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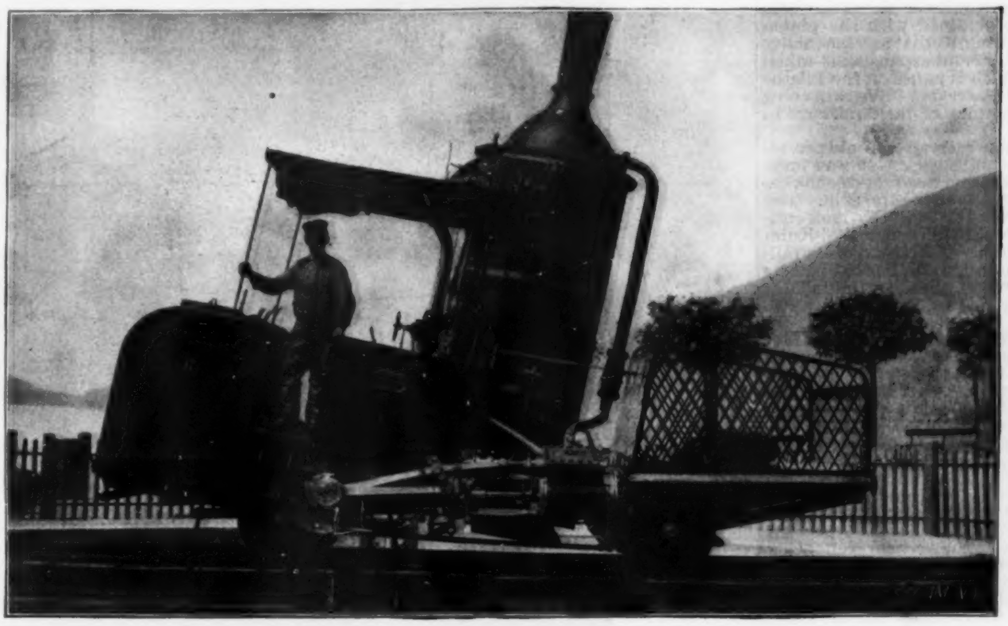
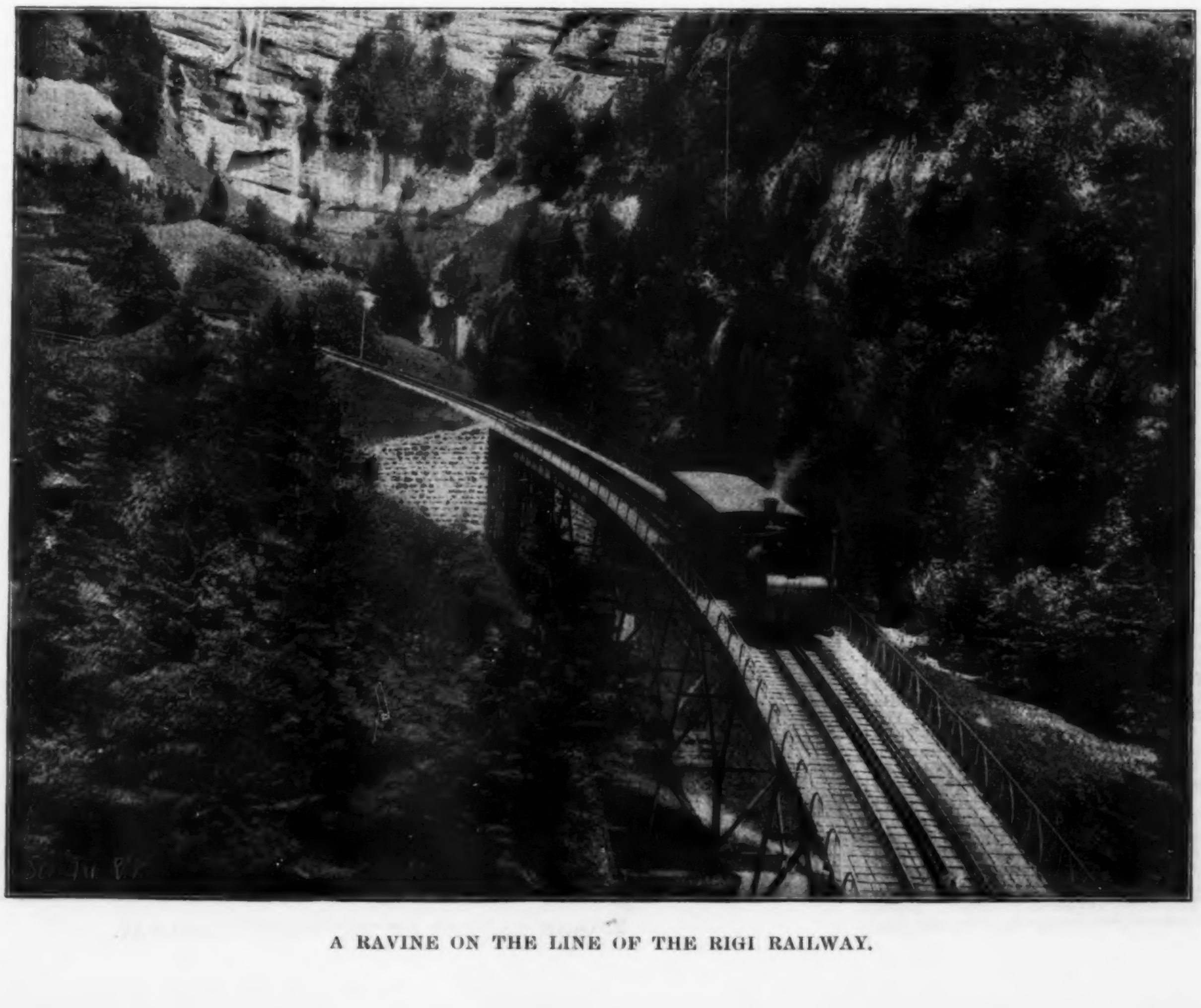
RACK RAILWAYS.



LOCOMOTIVE OF THE RIGI RAILWAY.

THE rack or cogwheel railway plays an important part in the railway systems of Switzerland and some other countries. There have been 70 lines built since 1812, and of these 17 are in Switzerland, 14 in Germany, 12 in Austria-Hungary, 4 in France and 3 in Italy, the others being in England, Spain, Greece, Portugal, the United States, South America, Asia and Australia. The total length of these lines is 500 miles and 188 miles of them are on the Abt system. The lines are worked by 300 locomotives, the heaviest of which weighs 70 tons. We give illustrations of four of these railways. Of course the introduction of mountain roads has been steadily opposed by those who are anxious to preserve the natural scenery from the vandalism of man, but however much we may deplore this condition of things still the mountain railway has always been popular with the tourists who overrun the "playground of Europe," and for those who wish to climb, the Matterhorn, the Eiger Jock and Monte Rosa still remain unsullied, but Mont Blanc (by its Mer de Glace railway, (see SUPPLEMENT 1063) and the Jungfrau (see SUPPLEMENT 1062) will shortly succumb to the two new projects. There will soon be scarcely a corner of Switzerland from which the white puff of a locomotive will not be visible. Among the fresh places to be attacked is the idyllic village of Morschach, which lies above Brunnen on the Lake of the Four Cantons. In the early years of the present century the rack railroad was proposed, as when the steam engine was first introduced it was thought there would not be friction enough to overcome the force of gravity when ascending grades, therefore the wheels of some of these early engines were studded with nails, the heads of which took hold of the wooden rails. In 1814, however, the fallacy of this scheme was shown. It was resurrected again in 1847 and was again lost. On August 12, 1863, Nicholas Riggenbach made application for a patent in France for a new system of track and locomotives for the ascension of mountains, and in 1871 he was one of the engineers who built the Vitznau-Rigi railway. In 1868-69 Sylvester Marsh constructed the Mount Washington railway, a rack railway analogous to the Riggenbach system, but the idea was formed independently. The success of the Rigi railway was the immediate cause of the building of a number of mountain railways.

Up to 1885 these lines were simple tourist lines, but it is to M. R. Abt that we are indebted for having made it applicable to roads intended for general traffic by the introduction of a new kind of rack and a new locomotive. The engines built on this system could run along ordinary rails by simple adherence until the grade become too great, then the rack mechanism is started and the engine hauls its load up the steep incline. As examples of this form of road we may cite the Brunig railway, the Oberland railway and the Viège-Zermatt railway. As examples of the continuous rack road may be cited the Vitznau-Rigi, Pilatus, Generoso, Brienz-Rothhorn, Glyon-Noye, Schynge-Platte and Wengernalp. The Rigi-Scheidegg and Uetliberg are examples of steep graded, simple adherence mountain roads. The Arth-Rigi road is a mixed railway though it differs from the Abt system. In the Riggenbach system two channel bars are firmly secured together at a



A RAVINE ON THE LINE OF THE RIGI RAILWAY.

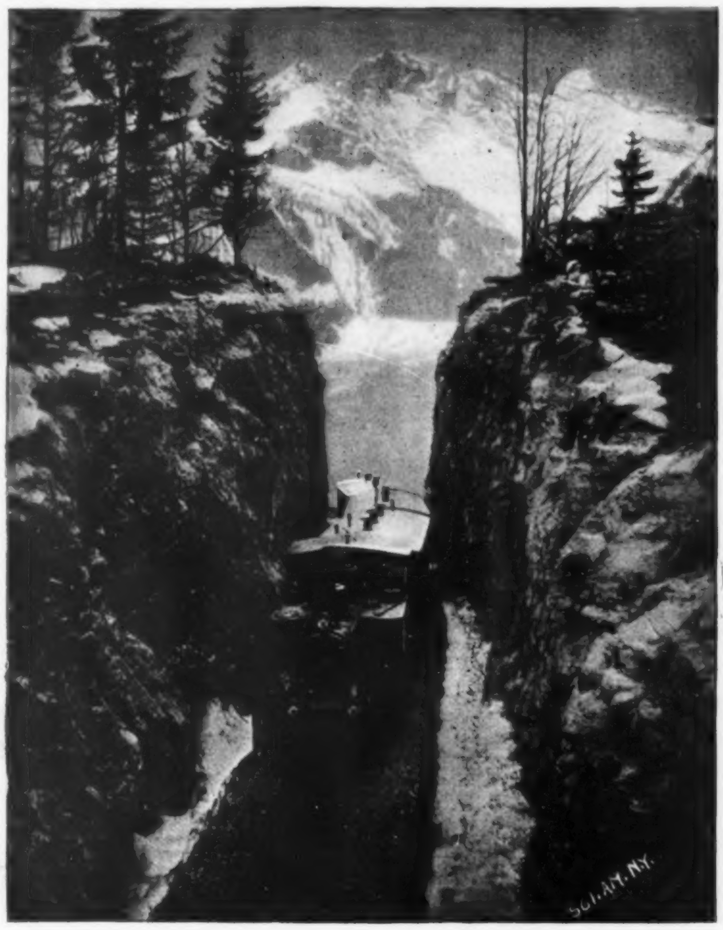
fixed distance and are secured to the foundation. At suitable distances pins are riveted in like the rounds of a ladder; into these pins mesh the teeth of the large driving wheels of the engine. In the Riggenbach or "ladder" system the old plan of riveting in the cross pins was finally abandoned, the pins being secured in place with nuts and washers so that any of them could be removed if it became broken. Of course the ladder being composed of several pieces had certain points of weakness, for instance, the trouble caused by expansion and contraction; the curves also required very special construction. In the Abt system the channel bars are each provided with teeth which mesh with the teeth of the compound drive wheel, thus insuring no loss of motion and comparative freedom from jar. In the Abt rail the teeth are staggered in the bars. The number and size of the bars depend upon the weight and velocity of the train and the grade. All motion of "creeping" is concentrated at the joints. There are no perceptible joints while riding on the cars, as two of the bars are never spliced in the same place, thus one bar at least is always continuous. The pinion from the engine is divided into as many disks as there are bars and an elastic connection is obtained with the pinion shaft by the medium of a spring, so that any inequality of workmanship or contraction and expansion is taken up. The Locher system, which is in use on the Pilatus railway, will be described later on. We will now consider some of the examples of rack railways in Europe.

The old Vitznau-Rigi-Kulm railway will always remain the classic rack railway of Europe. It was built in 1871 by Messrs. Riggenbach, Naeff & Zschokke, engineers, and it was designed with rare skill. The Rigi-Kulm is approached from two sides by rack railways, the Arth-Rigi-Kulm and the Vitznau-Rigi-Kulm railways. It is with the latter, which is the older railway, that we shall concern ourselves. A line of steamers brings the passengers up or down the beautiful Lake of Lucerne to Vitznau, where the railway starts. The length of the road is about 3¼ miles, and in this distance the line rises 3,937 feet, the gradient being at first 1 in 14·9, while after getting clear of the town it varies from 1 in 5·56 to as steep as 1 in 4, the average gradient for the whole distance being 1 in 4·45. The curves are all of the radius of 590½ feet. The principal works on the line are a tunnel 246 feet in length and a bridge over the Schnurtobel of three spans, which we show in our engraving. Both the tunnel and the bridge are on a gradient of 1 in 4; the bridge is also on a curve, the radius of which is 590½ feet. The central rack, into which the toothed wheels on the locomotive and carriage gear, is formed of two channel irons, each 4¾ inches deep by 2⅜ inches wide, the vertical web being ⅝ inch and the flanges ⅝ inch thick. These two channel irons are placed 5 inches apart and into them are riveted the ends of a series of pins or teeth formed of wrought iron. The gage of the ordinary rails is 4 feet 8½ inches. At each of the termini and at an intermediate point an arrangement is provided for shifting the trains to a siding or turn out. The locomotive, which has a vertical boiler, rests on four wheels. The connecting rods are coupled to cranks on the end of a shaft carrying two pinions which gear into spur wheels with 43 teeth keyed on the driving or lower axle. On this axle are placed the lower carrying wheels, while there is also keyed on its center the toothed wheel which gears into the central rack. This wheel is 2 feet 1 inch in diameter and has 20 teeth. The second or upper axle of the engine is also provided, besides its carrying wheels, with a central spur wheel which gears into the central rack, this wheel being employed for arresting the motion of the train by means of the brakes. Upward the trains are propelled by steam power; in descending the speed is regulated by an ingenious mode of introducing atmospheric air into the cylinder. The passenger carriage is placed in both cases above the engine, with which it is uncoupled, so that by a system of powerful brakes the car can be instantly stopped independently of the engine in case of accident. The speed hardly exceeds four miles an hour. The continual "joggle" is intensely disagreeable and will be remembered by all who have traveled on the road. Each carriage holds 54 persons and the fare up is $1.40.

From Lucerne to Brienz, Switzerland, or in other words from Lucerne to Interlaken, the Brunig pass has always been the great highroad, so that it is little wonder that a rack railroad has been built over this important line. The Brunig Railway was opened in 1888-89. As far as Giswyl, or about half way, the railway is the same as any ordinary narrow gage road, but from this point on to where it surmounts the pass, 3,295 feet above the sea level, it runs alternately on ordinary rails and on special rack rails, using respectively two sets of engines on the locomotive. It is very interesting to get out of the cars on the steep grades and watch the change from the ordinary to the third or rack rail. Each locomotive is provided with a speed indicator in the cab. The maximum gradient is 18:100, and the road traverses two tunnels and two rock cuttings, one of which is shown in our engraving.

Thousands of tourists annually visit Lucerne, and one of the most impressive views which can be obtained from this charming place is Mount Pilatus, which raises its rugged and serrated peak above the shore of the lake. Its steep rocky sides, its fearful precipices, and the general appearance of bleakness, serve to impress it on the mind. This really seemed the last Alpine fastness to be conquered by man, but two enterprising engineers of Zurich, Col. Locher and M. E. Guyer-Freuler, conceived the startling idea of constructing a railway to the top of Pilatus. This railway is one of the most audacious and wonderful pieces of engineering which the nineteenth century has been permitted to witness. Starting directly from Alpnach-Staad on the lake, the foundation consists of a continuous wall of solid granite covered with immense slabs of granite. All of the bridges even are masonry. The superstructure is of iron and steel, braced and bolted together. The rack rail runs midway between the two ordinary rails, but at a somewhat higher level. It is of wrought steel and has a double row of vertical cogs milled out of solid steel bars. Each engine and car which form a unit are provided with horizontal cogwheels which grip the raised rail rack from either side. Powerful air and friction brakes are provided which will work automatically in case of accident. Our engraving shows the engine and car. The boiler is placed crosswise. There are four compartments, each seating eight passengers. The speed is 65 yards a minute, both in ascending and descending.

The railway was opened in 1888, the actual construction having occupied only four hundred working days. None of the ordinary conditions of railway building obtained in this unique construction; progress could only be made at one point, and the railway grew upward like the stalk of a plant. As soon as a short stretch was finished, it was utilized for the transportation of material. Work in the open air had to be stopped in the autumn, but it was continued in the tunnels, one of which we illustrate. The gradient is here 42½ in 100.



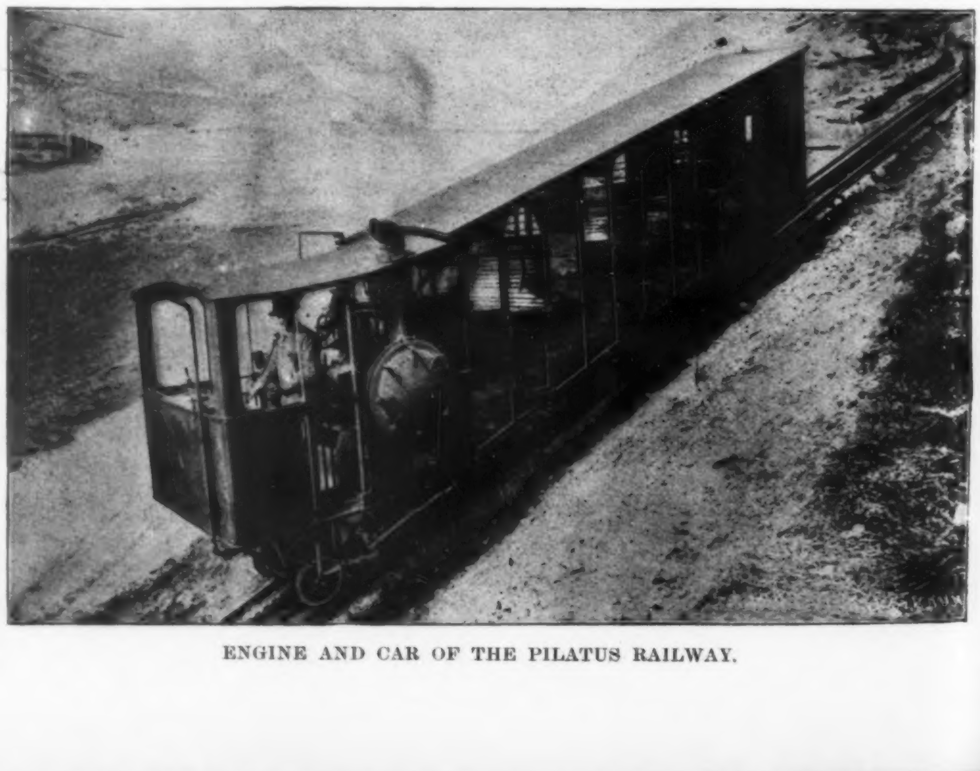
BRUNIG RAILWAY.

The following statistics are interesting: The height of the station above the sea level is 1,447 feet, the height of Pilatus-Kulm station 6,791 feet, the difference of altitude is 5,344 feet, the length of the railway is 5,049 yards (nearly 3 miles), the mean gradient is 42 in 100 = 22°47′; the maximum gradient is 48 in 100 = 25°39′. The total cost of the railway exclusive of the hotels at the top was only about $380,000.

We also illustrate a railway on a smaller scale, which is interesting as showing how well adapted the rack railway is to tourist railway purposes. The Drachenfels railway, which was opened in 1883, runs from Konigswinter on the Rhine near Bonn to the Castle of Drachenfels, 908 feet above the Rhine. The railway ascends the hill in an almost straight line and approaches the top like the road, on the farther side of the Rhine. Its length is 1,662 yards, its rise is 740 feet, and the steepest gradient is 1:5. The viaduct half way up affords a good view of the Drachenfels; there are eighteen trains each way daily, and the trip occupies only 10 or 12 minutes.

We also give a view of the ruins of the historic castle of Drachenfels, which is annually visited by thousands of tourists. It was erected by Arnold, Archbishop of Cologne, in the twelfth century, and after being given by him to a monastery at Bonn, it was held as a fief from the latter by the counts of the castle. From this rock came the stone which was used to build the Cologne Cathedral. The wine yielded by the vineyards on the slopes is known as Drachenblut or "dragon's blood." The cavern among the vineyards is visible from the Rhine half way up the hill, and is said to have once housed the dragon killed by Siegfried, who, having bathed in its blood, became invulnerable. As may be supposed, the admirers of Wagner's operas never fail to visit the cavern and the ruins of the castle when traveling on the Rhine.

We also present an engraving of an American combination six cylinder rack and adhesion engine, built by the Baldwin Locomotive Works, of Philadelphia, Pa., for the Santo Domingo Railway. It is the first locomotive of the kind ever built. As is the case with many of the European mountain railway locomotives, it can be used on ordinary rails or on the rack rail. The gage is 2 feet $6\frac{1}{16}$ inches. The drivers are 33 inches in diameter. The engine has three cylinders on each side, the top one operating the rack machinery. Aside from this there is a regular four cylinder Vauclain compound engine connected with two pairs of drivers. The other dimensions are as follows: Cylinders 11x18, total wheel



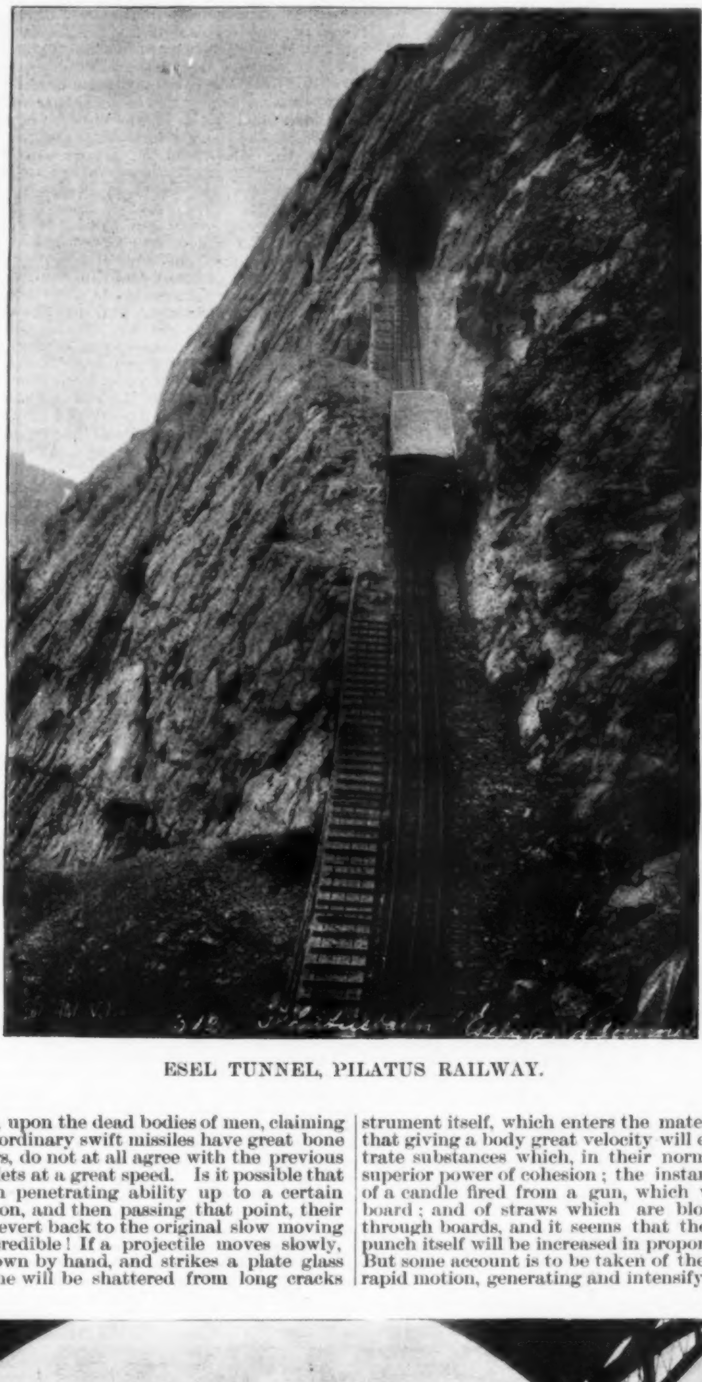
ENGINE AND CAR OF THE PILATUS RAILWAY.

base 9 feet 10 inches; total weight, 27,700 pounds; weight on drivers, 18,220 pounds; the diameter of the boiler is 42 inches and it has 94 tubes; the length of the tubes is 11 feet 10 inches; the capacity of the tank is 800 gallons.

PUNCHING AND SHEARING.

By PAYSON BURLEIGH, in the Age of Steel.

A RIFLE bullet in full flight will punch a round hole through plate glass. I know that, for I have seen it done. Those funny reports about the performance of the French arms, of similar powers with our Krag-



ESEL TUNNEL, PILATUS RAILWAY.

Jorgensen rifles, upon the dead bodies of men, claiming that these extraordinary swift missiles have great bone smashing powers, do not at all agree with the previous behavior of bullets at a great speed. Is it possible that they increase in penetrating ability up to a certain rapidity of motion, and then passing that point, their characteristics revert back to the original slow moving type? It is incredible! If a projectile moves slowly, like a stone thrown by hand, and strikes a plate glass window, the pane will be shattered from long cracks radiating from the point of impact. We ask this question, then, in regard to the presses used for punching and shearing iron and steel: Do they move at the most advantageous rate of speed? I asked a manufacturer of punch presses once if his press would stall without breaking, and he replied that it would "if it was run at the regulation speed." Of course if the balance wheel was given too much momentum something would break if the motion was suddenly stopped. That sets the proper limit of speed to the capacity of the machine.

Consider also the durability of the punch; the instrument itself, which enters the material. We reflect that giving a body great velocity will enable it to penetrate substances which, in their normal state, possess superior power of cohesion; the instances occur to us of a candle fired from a gun, which will penetrate a board; and of straws which are blown by cyclones through boards, and it seems that the potency of the punch itself will be increased in proportion to its speed. But some account is to be taken of the friction due to rapid motion, generating and intensifying heat, for if a body moves with sufficient velocity it will grow incandescent, as meteors do, even by the friction of the ether at the outer verge of our atmosphere (and, by the way, I wouldn't give a cent apiece for all the candles that ever were fired through boards if they looked as drippy and haggard as those I have experimented with). The limit of speed is fixed by the effect of friction upon the punch, but the quicker the speed the more direct is the stress in lines parallel with the line of motion.

THE DRACHENFELS RAILWAY.

As to shearing, iron generally shears smoothly enough if it is not too thick. But to achieve this result with the greatest certainty, it is necessary that the shear blades shall be properly designed, well made, set in the right position, and move steadily without the lateral deviation. The greater the proportion of the perimeter pressed upon by the shear, the more regular will it force the severed ends to be. It is for this reason that for shearing round iron, the blade is cut out to fit the same circle. If square iron is cut with flat blades, the line of strain may run obliquely to a straight line between the cutting edges of the blades. To avoid this the dies may be made in V shape, if the work is of such nicety as to require it, but not otherwise, as such dies are weak through at the bottom of the V. If the adjustments of the press will permit, this weakness may be remedied by increasing the thickness of the blade below the V, on the back side.

The fact that bars as much as an inch thick do not shear in a straight line when cut with flat blades, unless they are within a particular and rather narrow limit of hardness, is sufficient evidence that the stress does not follow in a straight line from edge to edge. It is a matter of common experience that only a small proportion of merchant bar iron, an inch thick, is of that peculiar combination of tenacity and hardness that the sheared section will evince, by its straightness, that the stress brought by the edge of one of the shears against the particles of iron with which it has come in contact has been transmitted in a direct line across the bar. If the shear moved quick enough, the motion would lack time to diffuse, but most of the iron of this size which is sheared tells the story that owing to the crushing effect of the stress, the particles are distorted and do not transmit it, from either shear, in a direct line. A pressure stress upon any substance is well represented by the pressure of a cannon ball, on the apex of a pile, upon the four in the square beneath it, and through them, upon the nine in the next square, and then on the sixteen in the next, and so on, the stress runs away to the ground from one point of contact to another, in slanting lines. If a six inch pipe is filled with sand and a three inch bar be pressed against the center on one end, the stress produced will be greater against the sides of the pipe at a short distance from its point of application than it will be in a line coinciding with the axis of the bar. So in a brick wall, a brick holds up more than one brick, for if you tear out half a dozen below, but leave a support on each side, you may rattle down from the second tier, five; from the third, four; and so on, one less from every tier; and in the seventh, the wall is as substantial as though its underpinning was solid. So in punching or shearing iron or steel, if the motion is slow enough to allow the lines of force to branch out, the cut will not be straight. The loose end is never cut square across in shearing, and it is a common device to reshear this end on work which requires that both ends shall be what in shop parlance is called "square."

In cutting up steel of uniform tone, or founder's temper, I have met but little which would shear well at a normal temperature. The tenacity is not so proportioned to the hardness as to meet the requirements for a good shearing cut. It breaks in and out, irregularly, displaying the unsystematic grouping of its congeries, but by heating it to a certain degree, quite often to that indicated by a blue color, even the most brittle severs with gratifying precision.

Considerable trouble in punching steel may be obviated by adopting the same expedient. It is not as convenient as it would be to punch it cold if it was not so refractory, and did not break punches, and produce such an uncertainty of operations as to make it impossible to predict before the stroke is given whether the piece submitted to it will have a hole in it, or be fractured and the workman have a hole in him. In the long run the greatest amount of work can be performed in a given time when the result of an operation can be predicted with reasonable certainty. In punching steel which is liable to have hard places in it which may cause the punch to break and pieces fly from it at random with violence, a due regard for the safety of the workman should be an inducement to adopt every known precaution against accident, and in this instance heating the steel will be nearly a complete insurance.

The die bed plate should be quite solid, rigid, not rendering to the stroke and springing back, for that circumstance has caused serious accident.

Unavoidable deformation of the stock is caused by shearing. Steel and iron which are soft enough to shear are compressible beyond the limits of elasticity and will retain some marks of the pressure necessarily brought to bear upon them to sever them with the shears. This is illustrated in the following instance:

Some flat disks were wanted about an inch in diameter and three-eighths of an inch thick. It was required that they should be quite round and cheaply produced, as they were to be subjected to perform the same duty as balls in ball bearings. These disks were to bear wheels which each supported from 600 to 1,000 pounds. The dies were so fitted into the press that when the shear was up, the one inch hole in each blade exactly matched the hole in its mate, and the bars of stock were turned so as to fit nicely in the hole. The bar was inserted through the bed die, and gaged so that it entered the ram die three-eighths of an inch, yet with all this precaution, the piece sheared off was nearly as badly deformed as it would have been if cut with ordinary semicircular blades without the exercise of unusual care. There are certain laws of mechanics which will persist in their operation regardless of human hope and desire, or bane or benediction.

Probably the best way to make these disks would be with a screw machine, or even with a hollow spindle lathe, such as are now available for use with more than one tool. This kind of a job can also be made cheaply by punching disks from $\frac{3}{8}$ inch steel plate with an inch punch. This punching will be made through a die $1\frac{1}{16}$ inches in diameter, and will, therefore, be an inch in

diameter on the upper side and flat, and on the lower side it will be $1\frac{1}{16}$ inches in diameter, and slightly rounded on the edges. Now by reversing it and punching it through a sharp inch die with a close fitting punch, it will be flat on both sides, and if made of good stock it will be as round, smooth and regular as its proposed use demands.

REPOLISHING JAPANNED WORK.

E. Hansche, in the Sewing Machine Times, gives the following directions for restoring shopworn machines to their pristine brightness: and they are applicable to bicycle work as well.

To get a new polish, send to a pharmacist or druggist and buy for five cents a little cream of tartar. This is a well known white powder, which is also employed for preparing seidlitz powders. Get also a little Vienna chalk from the druggist. This, with some cheesecloth (old and worn is best, but, old or new, it must be clean and soft, free from grit or roughness) is all the material required.

After removing all oil from the japanned parts, make a ball or pad of the cheesecloth, moisten it with clean water, put a little cream of tartar on it and rub gently and evenly over the whole surface of bed plate, arm and wheel. Go over it next with a dry pad and cream of tartar, and a third time, using then the Vienna chalk.

The cream of tartar cuts down the broken edges of the varnish where scratched, reducing it to a level surface, thus removing the scratches. The chalk restores the gloss.

Great care must be taken throughout the operation to have perfect cleanliness. One grain of grit on either of the pads would make new scratches more difficult than the others to remove. The rubbing must also be done gently and with discretion. It is easy to cut clear through the varnish—to take it all off—after which no gloss can be got. It must be remembered that this process takes off a part of the coat of varnish, and that the less so removed the better. Pumice stone would be too sharp for this work; it would remove too much of the varnish.

Although the last rubbing with the chalk has left a good smooth polish, the deep dark shine that is so beautiful to the eye can only be produced by the touch of the human hand, which, of course, must be clean. On the ball, or "mouse," as it is called, of the right hand, put a little chalk, and rub until the friction produces warmth, then will appear the finest polish that can be produced.

If any way apt, a person can within one hour polish two heads complete. It is of the greatest importance to warn everybody only to use the smallest possible quantity of force, in fact the least used the better it will be. In this way and by these means the new work in factories is polished by boys and girls who are trained to a great degree of skill.

In the case of old bed plates where the scratches go through the japan to the iron, the scratches should be filled with black japan, which must harden a few days before the polishing. If roughness or unevenness is caused by the filling, pumice stone may be used sparingly to level the surface.

It is sometimes desirable to remove a name or trade mark from an arm. This can be done very successfully with the cream of tartar. It is best done with the finger. Dampen the middle finger of the right hand, touch the ball of the finger to the cream of tartar and rub carefully. The important point is to stop rubbing when the purpose is accomplished. Polish with chalk as before. Much judgment is required in this operation, as the coats of varnish vary much in thickness on different machines.

THE DRACHENFELS.

GAS MOTOR TRAM CARS.

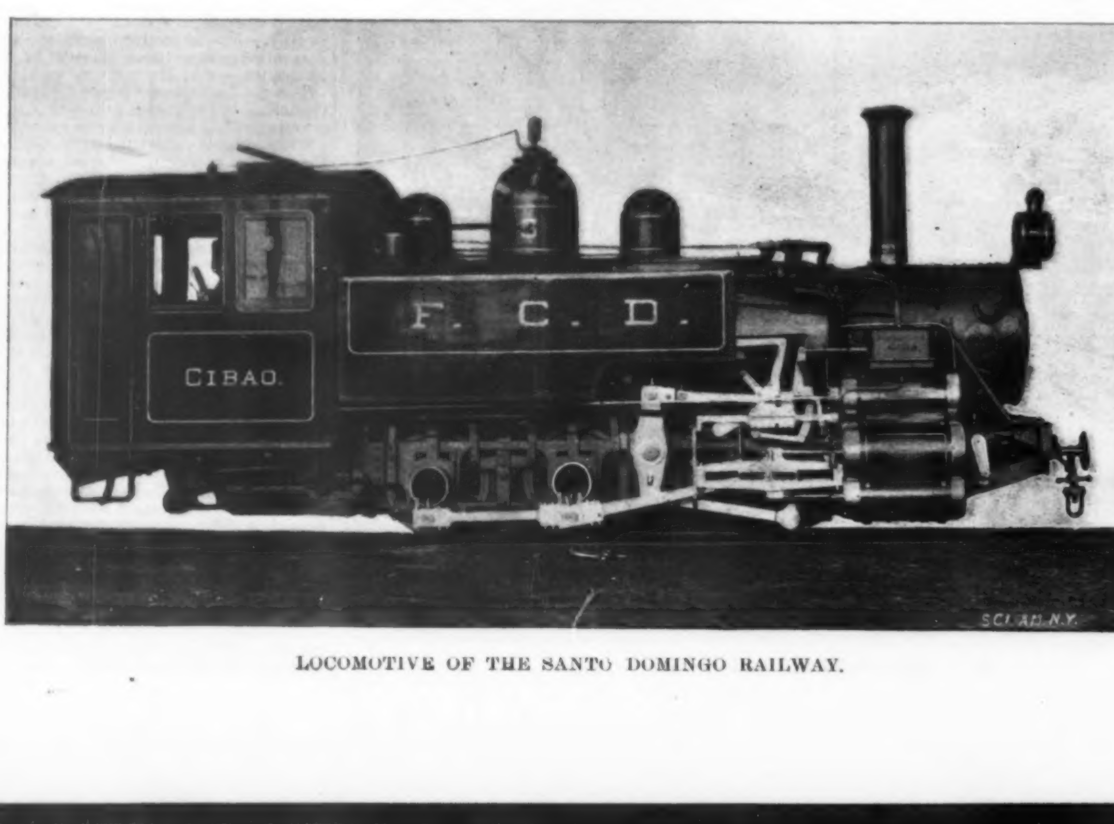
The problem of economical tram car propulsion seems to have now been solved by means of gas engines. The very high efficiency of this form of motor has for some time caused engineers to turn their attention to it as a promising motor for independent cars, and now after experimental, and finally commercial working in Germany with the Luhrig system, it has been proved in this country. What it has so long done in nearly every other application, even as a marine engine, it has now been called to do as a locomotive, or as a motor for a self-propelled tram car.

Recently a large party of those interested as engineers and local authorities in the working of tramways visited Blackpool to witness the inauguration of the new line of the Blackpool, St. Anne's and Lytham Tramways Company, and its operation on the gas engine system of the Gas Traction Company of London and Dresden.

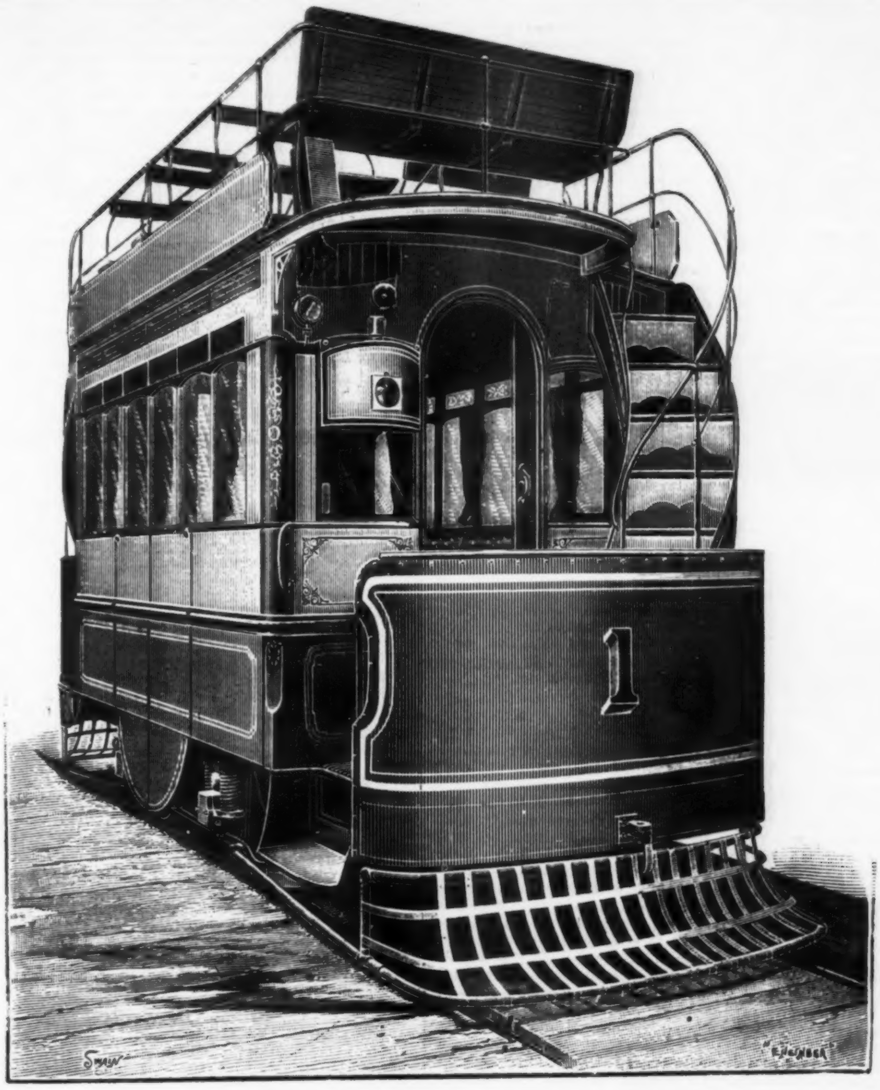
The tramway is not yet open throughout its whole length, in consequence of sewer work obstructions at St. Anne's, but of the total of about seven miles of line owned by the company and line run over at Blackpool, the inaugural runs were made over nearly four miles. Three cars were running, and met the party of visitors near South Shore Station, Blackpool. All are fitted with precisely the same form of duplex Otto engine and the same form of gearing. We illustrate one of the cars by means of a view from one end. By other engravings, which show the car without the top seats, we illustrate the gearing and the arrangement of the whole of the machinery and gas receivers. The cars carry sixteen passengers inside and twenty-four outside, are very roomy and well finished, and weigh, with everything ready for the journey, 7½ tons. The engine is about 14 horse power, and is placed on one side under the seats, and the gear is partly there and partly on the floor, as shown in the engravings. The engine has two cylinders working on the one crank, the pistons being 7¼ in. diameter and 9¾ in. stroke. The space on the side opposite the engine is fitted with gas receivers, and there are two other receivers transverse to the cars, as shown in the engraving. The water required for the cylinder jackets is carried in tubes on the roof, and circulation is maintained by a small pump; the water passing from one engine to the other in its circuit. The engines are balanced, one cylinder being opposite, or 180 degrees from the other, as shown in the engraving annexed. They are so arranged with regard to the gearing and governor that when on very easy roads only one of the two cylinders receives a charge, and thus less work is done and less gas used.

When stopping, not only is one cylinder cut out, but the speed of the engine is brought down from the ordinary 260 revolutions, subject to the governor, to about seventy-five revolutions per minute, the gas supply and the speed of the governor being altered by the movement of the hand lever, which throws the friction clutch of the driving gear out of action. At the same time the lubricating oil supply is reduced, so that no smell arises from the excess oil supply, which, under ordinary circumstances, collects when the engine runs light. This is effected by a very ingenious arrangement of the lubricator, by which its action is controlled by the taking of a charge of gas for the cylinder. No gas used, no oil used.

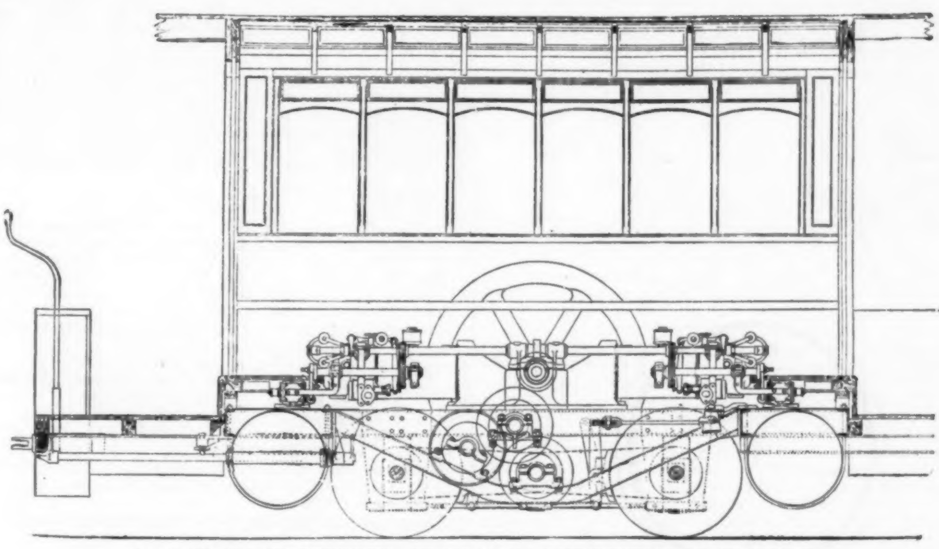
The engines and machinery are remarkably well balanced; so well that when the visitors approached and entered the cars, no one thought the engines were at work. When the full gas supply is given to one or both of the cylinders, and the gearing put into action by means of the wood-faced clutches, some movement is appreciable, but not more than ordinarily noticeable with any car when running. There is a little "dither" caused by the new and unworked cog wheels, but this will soon wear off, and there will be nothing by which travelers can distinguish between these and ordinary cars, except speed and horselessness. The gearing is arranged to drive from a first motion shaft to one or other of two second motion shafts by toothed wheels, and on these are two chain gear wheels, the chains



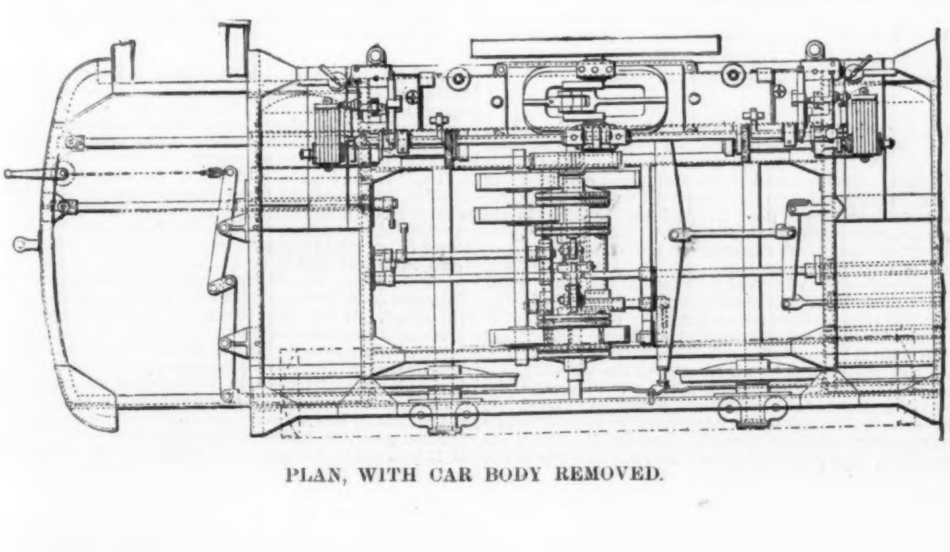
LOCOMOTIVE OF THE SANTO DOMINGO RAILWAY.



GAS PROPELLED TRAM CAR.



GAS MOTOR PROPELLED TRAM CAR—LONGITUDINAL SECTION.



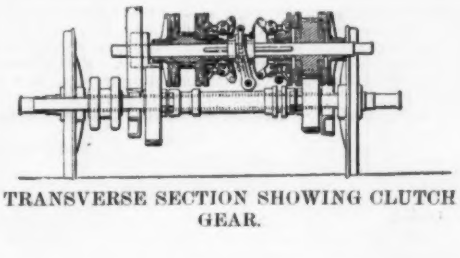
PLAN, WITH CAR BODY REMOVED.

from them conveying motion to the one or other axle for driving the one or the other way. The clutches and gear give two speeds, one 8½ and the other about 4 miles per hour. To effect this change, the one or other clutch is thrown in or out of gear by one lever, the arrangement of the clutches being shown herewith. Our engravings are sufficiently explanatory to require no further description from us. The compressed gas is supplied to the receivers on the car from a stand pipe connected with the large gas holders at the pumping station, by means of flexible tubes and valves with spigots, like those used for supplying compressed gas on the Pintsch system to railway carriages.

With respect to the working, every one present was agreed that even on very sharp curves the working of the machinery was eminently satisfactory, and the only gradient of any note, namely, 1 in 30, was mounted with perfect ease, the slow speed gear being put to work for this purpose. It was noticeable that this was not done until after the car had begun to mount the hill, and the change even then was so easily made that those who did not know the change was being made did not notice it.

With regard to the system, it will be noticed that every car is perfectly independent, and can at any time be put on any tramway. The plant necessary for compressing the ordinary town gas which is used is very simple, and consists of one gas engine driving a compressing pump, which delivers into two large Pintsch gas receivers at a pressure of about 150 lb. per sq. in. The whole cost of the compressing plant, or in other words the whole cost of the installation for say six cars, is only about £350, and the plant is portable. The system is, therefore, the simplest of all yet introduced, and as it has now been running more than two years with complete success in Dresden, and over a year in Dessau, the cost of working by it has been ascertained. The cars and their machinery have received many important improvements since the Gas Traction Company acquired the rights from the Luhrig Company in Germany.

The results of the running in these two towns are as follows: Dresden, with gas at 3s. 4d. per 1,000, the cost per car mile is 1·23d.; in Dessau, with gas taken at 2s. 11d., the cost is 0·9d., the gradients in the latter town being small. The cost of running these cars in towns where the gas works are owned by the corporations would be very much less than this, but even at these prices the relative cost of traction in Germany including everything is found to be, by horses, 5·5d. per car mile; electric traction, 4·25d.; and gas traction, 3·25d.; and this as against other mechanical means takes no account of the great value of the independence of every car, and of the cars as to the system of line.



TRANSVERSE SECTION SHOWING CLUTCH GEAR.

The cars which we illustrate were built for the Gas Traction Company by the Ashbury Carriage Company. The Blackpool, Lytham, and St. Anne's tramway, for which the bill has passed, and is only waiting royal assent, has been designed and constructed by Mr. Chadwell, C.E., of Blackburn.—For our engravings and the foregoing particulars we are indebted to the Engineer.

CLEANING CAVITIES IN METAL WORK.

To get the cores entirely removed from small castings is something of a job, and tumbling does not always do the work satisfactorily. Here is an idea that is worth trying, says J. H. Allen, in Dixie, as I have seen it worked successfully in one place. It should be added, however, that it is only applicable to brass. Before the casting is perfectly cold dip it into water, and the steam formed on the surface of the metal will blow off every particle of sand and leave the casting as fresh and clean as though its interior had been made in a tumbler and run until it was worn bright. It will not do to be careless in the handling, since if the metal is plunged in too hot it is apt to be softened or cracked; but after a short experience the scheme can be worked as a great labor saver. The man I saw using it would handle his pieces about as fast as the ordinary laborer could be prevailed upon to throw them into a tumbler. This use of steam is a great thing for blowing chips out of the bottom of a deep hole. A few years ago I had occasion to drill some ¾ in. holes into a shaft to the depth of 13 in. To clean them with a worm and waste was simply impossible, but a blast of steam from a 3-16 in. nozzle run down to the bottom of the hole did the work in about 30 seconds. We used steam because we did not have compressed air, but the latter would have been more satisfactory still, since it makes no sloppy muss. And, apropos, how can any one in this day and generation get along without an air compressor and hoists? While I am on the subject of cleaning out deep holes, let me add that, when they are being drilled, the drills sometimes break off short, and this will surely be when the hole is nearly finished, and the piece left behind is invariably wedged into the hole in the tightest manner possible. I drilled the holes above referred to with home made flat drills and breakages were not uncommon. On the first occasion I attempted in vain to pull the piece out, but a resort to gunpowder did the job. I poured in enough rifle powder to cover the piece, first running a fast burning fuse down to the bottom of the hole, then rammed in about 2 in. of paper and touched it off. There was a report, a scattering of coal in the bin toward which the improvised gun was aimed, and the broken end of the drill was lost to our sight forever, while a fresh drill was used to finish the hole.

CYCLE MECHANICS.

By H. K. Landis, E.M.

The amount of interest manifested by the American people in this form of locomotion and physical exercise has justified the investing of immense sums of money in the manufacture, advertising, and sale of cycles, and the establishing of an industry which already is making itself felt as a factor in the business world. Tobacconists do not sell as many cigarettes; jewelers find the usual presents a growing drug on the market; piano manufacturers complain; theater managers look worried, while saloon keepers yawn in their doorways; and all because a pleasant outlet for stored-up vitality within the reach of all has appeared, not as a fad of the hour, but as the result of eighteen years of development. The present "safety" model was designed scarcely eight years ago, while the universal pneumatic tires have been in use but five years, and yet the men who furnish recreation to our people already claim disastrous inroads into their province by the new industry. In this development the most noticeable feature in bicycle construction has been a reduction in the weight of a machine from 35 to 60 pounds in 1879 to 18 to 26 pounds in 1896—approximately a 50 per cent. reduction. Granting that the material used was not excessive in quantity in the first machines, it naturally follows that the material and method of design is twice as efficient in a '96 model. In this shaving down process the experience of the repair shop, and graphical solution of stresses, supplemented by data obtained by actual laboratory tests, were put to use, for the cycle of to-day is a complicated mechanism which usually breaks where least expected. The factor of safety in the present machine may be taken at 1⅛, so that, with this small margin of safety, it is necessary for the rider to know just where the weak points are in a machine, and just how much stress they will bear, in order that he may avoid accidents and understand the whyfore of the various facts he learns by experience. To this end the experiments which follow were undertaken, and in order that each wheelman interested may make the tests for himself, the method employed will also be described.

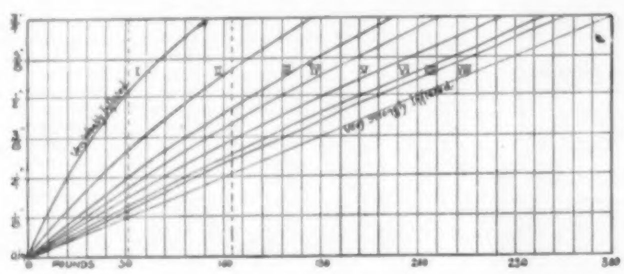


Fig. 1.—COMPRESSION OF INFLATED CYCLE TIRES UNDER VARIOUS PRESSURES.

I. STATICS.

Weight Distribution.—Let us take a rider who weighs 131 pounds and a fully equipped wheel which weighs 25 pounds, or both together 156 pounds. Place the machine with rider so that the fore wheel rests upon a platform scales; when his body is in the position of coasting, the scales read 46 pounds; erect, 47; average position, 52; middle position, 57; scorching, 60. Or, in the average position of a graceful rider, one-third of the weight rests on the forward wheel, and the remaining 66⅔ per cent. on the rear wheel. In order that the tests should be amenable to comparison, they were made on a Columbia road machine. Pulling up on handle bars decreases this weight about 3 per cent., back pedaling increases it about 2 per cent., while forward pressure on the pedals decreases it about 6 per cent. These figures will vary somewhat for each rider. From this we conclude that the forward wheel rarely carries more than one-third the weight in ordinary riding. On a hill rising 10 feet vertical in 100 feet horizontal, this weight will increase to 60 pounds going down and decrease to 40 pounds when coming up.

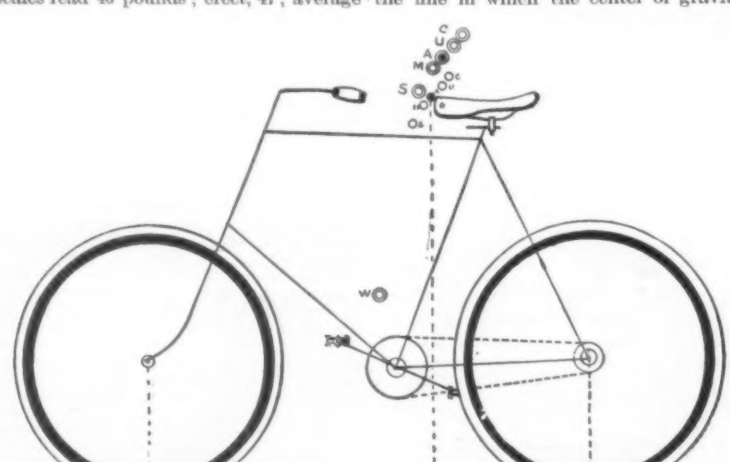


Fig. 2.—CENTER OF GRAVITY.

Weight of equipped wheel, 25 lb.; weight of rider, 131 lb. Double circles are the centers for wheel and rider alone, while single rings are for both together. C, coasting position; U, upright; A, average position; M, medium between U and S; S, scorching attitude; W, wheel alone.

Compression of Tires.—Leave the wheel in the same position supported by a rope about the seat post and tied perpendicularly to the plane of the machine; attach a large wire loop to both shaft nuts of the forward wheel; put a 12 foot bar through this loop with the short end attached to the floor and the other in the hands of an assistant; another man may note with a rule held vertically when the tire is compressed the required distance, while the pressure applied is read from the scale beam. The tire is first inflated very hard and the weight taken every eighth inch compression; after this series a little air is allowed to escape and another series taken. When the results are plotted, they will resemble the curves here given. The deductions to be derived from the test are that very hard blown tires follow Prof. Kick's law of proportional resistances, i. e., the ratio between the pressure required and the deformation produced is constant and the curve a straight line. But as the tire becomes less and less inflated, the ratio of pressure to compression decreases gradually as the pressure increases. The natural deduction is that very hard tires have a constant degree of elasticity under all degrees of compression, while soft tires compress easily under small pressures and less so as the pressure increases. They are therefore easy to ride on roads where the vibrations are small, as the long swings of soft tires are cut up by the many vibrations which would make a hard-tired machine tremble uncomfortably. But on roads whose amplitude of vibration exceeds ⅜ inch comparatively loose tires should not be used. A tire must never be loose enough to allow it to compress until against the rim, and thus transmit shock to the frame, and as this would happen at half the pressure with a flabby tire as with a firm one, such loose tires should not be used on rough roads, and should be ridden cautiously over car tracks, crossings, etc. A compression of ⅜ of an inch under the weight of rider and machine will represent probably the general safe and at the same time comfortable degree of inflation. Cyclometer readings depend upon the compression of the tires. A hard tire without rider traverses 7 feet 4 inches, with rider 7 feet 1⅛ inches, while a tire where 132 pounds compresses it ¾ inch will traverse but 7 feet, a loss of 5 per cent. for the cyclometer.

Center of Gravity.—Let us conceive the horizontal distance between the shafts of the fore and rear wheel as a balance arm having the weight on the fore wheel tire on one end and that on the rear wheel tire on the other; as the wheel is in equilibrium, this balance arm would be supported at its center of gravity and, therefore, the weight of the forward wheel times its end of the balance arm, which we will call X, will equal the weight of the rear wheel times its horizontal distance from the center of gravity, 45·5 — X inches, or $52 \times X = 104\,(45{\cdot}5 - X)$, from which $X = 30{\cdot}3$ inches from the fore wheel shaft. A vertical through this point will be the line in which the center of gravity will lie. By changing the elevation of the rear wheel, another locus of the center of gravity is obtained in the same manner with the platform scales as in the first test mentioned. By taking observations with two different elevations of 15 and 20 degrees inclination on both wheels, including the horizontal, there were five loci found which should have gone through the same point. The intersections were close enough for the purpose, and showed the center of gravity of machine and rider whose body inclined 20 degrees from the vertical to be at the forward point of the saddle on the machine tested. On the cycle diagram will be seen the center of gravity of rider (double circles), rider and wheel (single circles) and of the wheel (W) in their relative positions; these will vary, of course, with the weight of rider and design of the wheel. It is a curious fact that these centers lie in a line with the point of contact of the fore wheel with the ground. It will be seen that the center of gravity is highest while in a coasting position; in case a great obstruction is encountered, the position of the feet at the top of the forks will prevent the body leaving the wheel and the whole weight will be raised through the height of one foot and take a header. When the rider has his feet on pedals he is simply projected forward over the handle bars, the machine remaining behind, so that the striking energy imparted to the wheel by the high velocity and mass will be that due to the motion of 25 pounds instead of the total 156, leaving a wheel unhurt which would otherwise be wrecked; the rider—well, he somehow escapes with a couple of bruises and has a good story to tell while resting under the shade of some wayside tree. This wheel would overbalance on a 60 per cent. up grade or a 112 per cent. down grade, hills usually not attempted in riding.

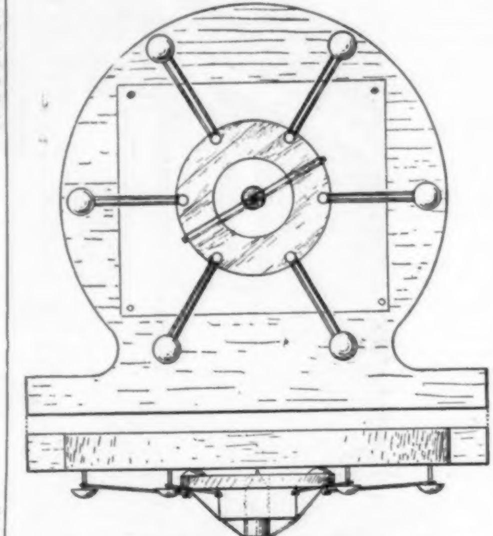


Fig. 3.—SEISMOGRAPH FOR RECORDING VIBRATIONS IN BICYCLES.

The style passing through a lead weight is held in place by rubber bands. Instrument is attached to upper tube in front of saddle.

Strength of Parts.—It is estimated by those who have given the subject some attention that the factor of safety of a '96 cycle is but 1·5, or that it is but 1⅛ times as strong as it should be, while in most other mechanisms it is 4. This is a small margin for accidents, but the demand for light wheels has been so strenuous that they were put out at the sacrifice of strength. There is but one way in which this can be compensated for, and that is by using the highest grade material obtainable, regardless of price. The present low carbon (0·20 per cent. carbon) steel used in bicycle construction requires 70,000 pounds to pull apart a one inch square bar; a high carbon (0·50 per cent. carbon) steel will require 90,000 pounds, and a nickel steel untempered 100,000 pounds. After annealing, which is the condition of all brazed parts, the strength of low carbon steel falls to 50,000, high carbon steel to 65,000 and nickel steel (5 per cent. nickel) remains about 100,000; so we see there are two superior metals already within reach which will probably be used in the '97 machines. Concerning handle bars, there is not much to be said except that a soft steel bar can be bent by an ordinary strong man, though a tempered nickel steel bar requires a pull of over 450 pounds to bend it—more than the average rider will care to exert. This means that nickel steel quenched at about 1,600 degrees Fah. has a tensile strength of 200,000 pounds a square inch or over. This, to the man accustomed to work structural steel, may seem an exaggeration, but the writer has seen it done daily with compression disks for United States ordnance at the Bethlehem Iron Company's works, and without causing the steel to become at all brittle.

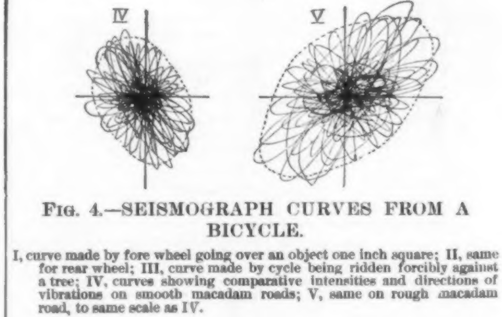


Fig. 4.—SEISMOGRAPH CURVES FROM A BICYCLE.

I, curve made by fore wheel going over an object one inch square; II, same for rear wheel; III, curve made by cycle being ridden forcibly against a tree; IV, curves showing comparative intensities and directions of vibrations on smooth macadam roads; V, same on rough macadam road, to same scale as IV.

It will require a ton and a half of weight gradually applied to the seat post to crush a frame of good steel, and yet 700 pounds horizontally applied to the front wheel shaft (the rear one being fixed) will cause the lower front tube to buckle on its lower side; the upper front tube will buckle on its upper side by reason of vertical forces. The front quadrangle is poor construction, and owes its strength to the stiffness of the jointing alone. When the joints are strong enough, the stress falls as a bending moment on the tubes, producing buckling usually about three inches behind the steering head. It is to be hoped that, at some future day, this style of truss will be modified in accordance with the best methods employed in bridge design. The chain usually has a factor of safety of 7; at a speed of 10 miles per hour there will be a pressure on the pedal of 47 pounds and a tension on the chain of 106 pounds.

The method of determining this is simple. Pressure on pedal times length of crank center to center will equal the tension on chain times the radius of large sprocket wheel, or power times power arm equals weight times weight arm. Thus:

$$47 \times 6{\cdot}75 = X \times 3, \text{ or } X = 105{\cdot}75.$$

A tire at ordinary inflation will squash flat at 450 pounds and will burst at 200 pounds per square inch pressure. A wheel will buckle at from 600 to 800 pounds pressure. When a joint is brazed carefully and pinned, the tube will break before it pulls out, but, unfortunately, even the Roentgen rays will not show defects in brazed joints, and those manufacturers who depend entirely upon brazing to hold their tubing together are often troubled with tube pulling out. With a first grade wheel, two million successive bumps are necessary to break it, while cheap wheels break under one-third that number. Low carbon steel tube subjected to successive stresses beneath, but near, its elastic limit will break at the end of 300,000 revolutions; high carbon steel will withstand over 400,000 stresses; while nickel steel requires a million and a half. It must be remembered that cold drawn steel tube is never as strong as the steel in the original billet, so that a bar of these materials will give higher results.

II. DYNAMICS.

Traction.—The writer has asked of a number of wheelmen their opinion as to the force required to push them along, and received answers ranging from 20 to 75 pounds, the average estimate being 50 pounds on macadam roads. According to D. K. Clark's formula for locomotive traction on iron rails, a drawbar pull of a pound is necessary for a weight equal to that of a bicycle. Robert Wilcox, of London, has deduced the equivalent for bicycle traction in ounces as

$$T = \frac{v^2}{100} + 7{\cdot}75,$$

adding 0·5T for speeds over 5 miles per hour. For 10 miles per hour this would be a traction of 13·12 ounces. Mr. Rudolph Hering, our eminent civil engineer, states that the traction on good macadam is eight times that on iron rails. Applying this factor, we get a tractive force necessary of 6·56 pounds. This disagreed so far from the wheelmen's estimates that a spring balance was tied to a machine and a horse drew the writer along at the speed required with feet on pedals, but exerting no driving force, along a good macadam road, giving the average drawbar pull as 4 pounds, and on mud roads as 6 pounds. These tests were repeated to confirmation, showing, in addition, that increasing the speed appreciably increased the power required, and that ordinary hills required 12 to 16 pounds to climb. Any wheelman can make these tests himself. The resultant of 4 pounds horizontal pull and 156 pounds vertical was so near the vertical that tire adhesion was very little decreased; in fact, it would require a tractive force of about 25 pounds to decrease the weight on tires one pound, so that tires are not at all liable to slip on firm roads. A formula for determining traction would necessarily be an empirical one, including a coefficient for each kind of road, the velocity of travel, weight of machine and rider, and a constant for friction of bearings and tires. However, the spring balance pull will give exact results, though not with the same degree of analysis that formulæ would. If records were kept by clubs and individuals of the traction and vibration on the roads they ride over, and these data incorporated in their road maps, it would tell wheelmen exactly what they want to know and do away with such elastic grading as pretty good, fair, middling, etc. All that is required for traction is a small spring balance half a pound in weight and a strong cord attached to the balance by which a companion wheelman can tow him along.

Pressure on Pedal.—This is derived directly from traction. At the speed of 10 miles an hour the foot should press upon the pedal uniformly throughout the half revolution with a pressure, P, the total pressure by both feet per revolution being 2 P; however, while this pressure, which is only entirely effective at half stroke, is moving through the diameter of the crank circle (1·125 feet) by a roundabout way, the resistance, which is constant, acts through the semicircumference,

$$\text{and is, therefore, } \frac{P}{1{\cdot}57} \text{ pounds, or } \frac{2P \times 1{\cdot}125}{1{\cdot}57} = 1{\cdot}43\,P$$

foot pounds per revolution of the crank. While the crank makes one revolution, the wheel tested traveled 16·86 feet. Ten miles an hour is 14·7 feet per second; therefore, the work done on the pedal would be 1·24 P per second, which is equal to 4 pounds traction acting through 14·7 feet or $4 \times 14{\cdot}7 = 1{\cdot}24$ P, from which P = 47 pounds on smooth macadam, and for 6 pounds traction 71 pounds on mud roads. This pressure can also be determined by a spring or compression dynamometer placed on the pedals or by a strong rubber bag placed on the pedal and connected by means of a tube to a pressure gage fastened to the handle bars.

Work Done.—Four pounds acting through 14·7 feet

$$\text{per second will require } \frac{4 \times 14{\cdot}7 \times 60}{33{,}000} = 0{\cdot}106 \text{ horse}$$

power per minute, or 0·636 horse power per mile. This can also be found from the pressure on the pedal. In either case this quantity of total work is done by the rider.

Energy of Motion.—When a wheel stops suddenly, the quickness with which the rider gets off his machine depends upon his weight and the velocity at which he is going. A number of experiments were made to determine the static pressure exerted upon the front wheel when stopped suddenly. Not possessing an accurate dynamometer for high pressures, the spring balance with sliding recorder was attached to the long end of a 19 to 1 lever and the other fastened to the bicycle as it passed. At the velocity of 4·47 miles per hour the recorded pull was 11 pounds, which was equivalent to 200 on the cycle. Eleven pounds caused the index to pass through $\frac{1}{16}$ foot, or $\frac{11}{16}$ foot pounds on a leverage of 19 = 17·4. The actual weight stopped was the weight of the machine, as when the pedals are vertical the body leaves the saddle at once on stopping. Energy of motion, therefore, will be represented by $\frac{1}{2}Mv^2$ or $\frac{1}{2} \times$ [illegible] $\times (6{\cdot}56)^2 = 17{\cdot}2 \times$ lever arm $1 = 17{\cdot}2$, coming very closely to the work done on the balance. However, when the rider purposely clung to the saddle, or when the pedals were in a position where he could brace himself against them, the energy of motion was higher, showing that 8 pounds in one case and 30 pounds in another of the rider clung to the machine. The average pressure was about 250 pounds for a velocity of 4·5 miles per hour, which would be just sufficient to compress the tire up to the rim. At the velocity of 12 miles per hour, however, this pressure would be sufficient to crush the wheel, while eight miles per hour would endanger the frame at a point on the lower tube near the steering head.

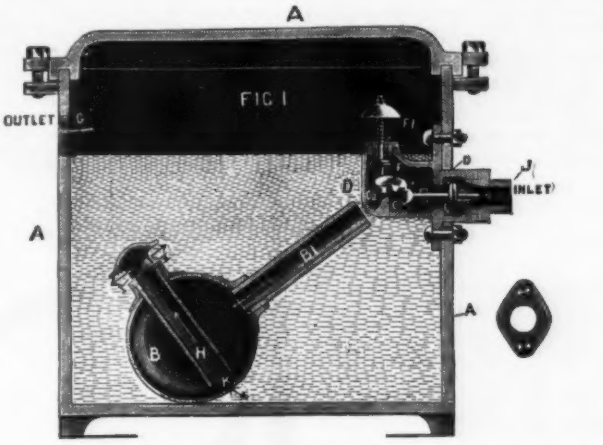
Vibration.—There is more enthusiasm stored in a smooth road than the civil authorities are willing to acknowledge. Personal comfort of the rider is directly proportional to freedom from loose stones, ruts, and jolts on the road. In considering the best means to record such vibrations occurring near the center of gravity, the ordinary seismograph was found too inconvenient, as vibrations were often too great; relative results and direction of vibration were what was wanted. The instrument was, therefore, constructed as here shown, and the accompanying curves secured. It will be noticed that the pencil style, held against the paper by the tension of a rubber band, is free to move in all directions against approximately equal resistances. We have not the space at disposal for a full discussion of these curves. They can be calibrated to actual distances by riding over a series of objects whose height is known, and noting the amplitude of the resisting vibration curves. In the impact curve (III) the first sharp dip indicates a sharp rising of the rear wheel while the tire is compressing, the long top curve to the rear the measure of the shock, and the deflection in the upper lefthand corner a settling back of the rear wheel. When the front wheel passes over an inch obstruction (I), the resultant vibration is in the direction of a line drawn through the saddle pommel and a point about 4 ft. in front of the point of contact of the front wheel with the ground. When the rear wheel passes over the same object (II), the vibration is in a line with the saddle pommel and a point slightly above the rear wheel shaft. These two lines of vibration make a little more than a right angle with each other, and thus the writer gets the maximum effect in an all around shaking up. On a smooth road there is more rear wheel vibration (IV), and here an easy saddle would do good service, but on a rough macadam road the front wheel takes the line of vibration through its shaft (V) and makes good its claim to the majority, and here is where a scorcher longs for springs on his handle bars. This is a subject which bears extended investigation, and especially so as motor cycles and horseless carriages are coming into the field for those comfort-loving folks who object to any very vigorous shaking up.

Economic Considerations.—The bicycle in its various forms has had a marked effect on road making. Philadelphia has a toll road for wheelmen alone. Brooklyn has a cycle path across Long Island. Pressure is brought to bear on civil authorities everywhere which induces them to improve their roads. Vibration and traction affects the citizen on a wheel as well as the "cabby" on a coupe, or the unfortunate passenger in a Fifth Avenue stage. As a result, the abomination of rough macadam or granite blocks is rapidly giving way to asphalt in the East, and vitrified brick in the West. The traction on asphalt is one-quarter and on brick one-third that on good macadam streets, so that the reason for this preference is evident. If wheelmen everywhere would collect traction and vibration data, they would aid the work on good roads and win the applause of engineers who are working to the same end. Such records are more convincing than high priced opinions.

A NEW STEAM TRAP.

THE accompanying illustrations, for which we are indebted to the Engineer, show the construction of a new steam trap now being introduced by Mr. Edward Yates, New Mills, Stockport. It is claimed that this steam trap is essentially distinct in principle from all other traps. When steam is turned into pipes or apparatus that this steam trap is connected to, the action is as follows:

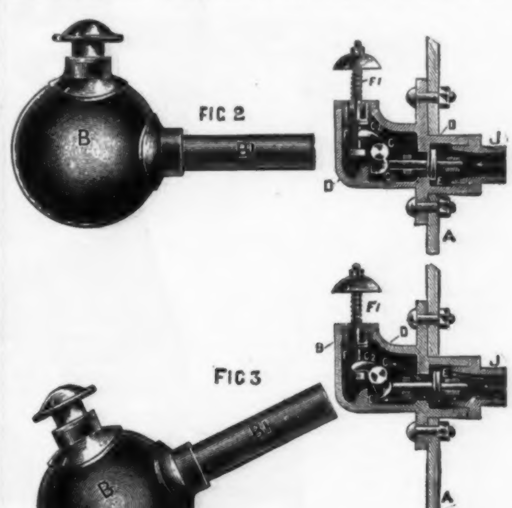
The copper ball float, B, is at the bottom of cistern, A, and causes the cam, C 1, to hold open the entrance valve, E, and cam, C 2, to hold open the air valve, F, against the pull of the spring, F 1; these cams are on a pivot, C, in the small valve and cam chamber box, D, and are connected to float, B, by float arm, B 1; the air which always comes first is blown away through the air valve, F, into cistern, A, and then away through the outlet, G, instead of entering the float and causing it to rise prematurely, as is the case with some other traps. The water will next flow through the valve, E, into the chamber, D, and down the elbow pipe, B 1, into the float, B, up the down pipe, H, and through the outlet holes, I, into the cistern, A, and away through the outlet, G. The steam at last follows the water, and as the area of the steam inlet valve is greater than that of the air valve, the air cannot pass the steam admitted by the inlet valve, so it at once forces the water out of the float up the down pipe and leaves it buoyant. It immediately rises (Fig. 2), relieving the position shown in the cams from the valves and allowing the pressure to close the valve, E, and the spring, F 1, to close valve, F, without loss of steam, or hammering of the valve faces on the seating. There is a small hole, K, in the bottom of the float, B, which begins to fill from the water in the box, A, consequently destroying its buoyancy and causing it to fall and force the cam, C 1, against the entrance valve, E, and push it away from its seating. If live steam be there, it will at once rise and allow valve, E, to close again as before without loss of steam; but if



A NEW STEAM TRAP.

water be present, it will receive it all. Cam, C 1, operates on the entrance valve, E, first, and will discharge all the water without disturbing the air valve while working, and only open the air valve when the apparatus is stopped.

Its action is similar to that of a man standing by a wheel valve and keeping it open so long as condensed water is flowing out, closing it as soon as steam appears, slightly opening it again to see if there is any more condensed water, and, if so, keeping it open and



A NEW STEAM TRAP.

allowing all condensed water to escape, and closing it as soon as steam commences to appear, and so on alternately.

HINTS ON BAKING ENAMEL.

THE frame and parts to be enameled must be perfectly clean and bright. The writer polishes them by using very fine emery cloth, being particularly thorough around the joints. After polishing, the first coating is applied with a camel's hair brush (or a badger flowing brush). The enamel is applied as fast as possible. Care should be taken not to go over the same place twice, as it sets very quickly and the brush will pull if it goes over a second time. If the brush is kept filled it works better, whereas, if it were wiped out it would pull. By putting it on rather thick or heavy when heated, it becomes thin and flows, whereas, if only a little was put on and brushed out it would set and there would not be enough to flow when heated. After enough of the work has been covered with the first coat to fill the oven, the work is placed in the oven and a little heat is turned on, and the temperature is gradually raised to 160° and kept there for the first hour. Then a very little more heat is turned on and gradually increased, until it reaches 220°, and it is kept at that temperature for the next two hours. At the end of the third hour the temperature is still further raised, until it reaches 250°, and it is kept there for the fourth and last hour. Then at the end of the fourth hour the heat is turned off, but the oven should not be opened for an hour or so until the work has had time to cool off. Then it is taken out and rubbed down with pumice stone ground fine, which is applied with a

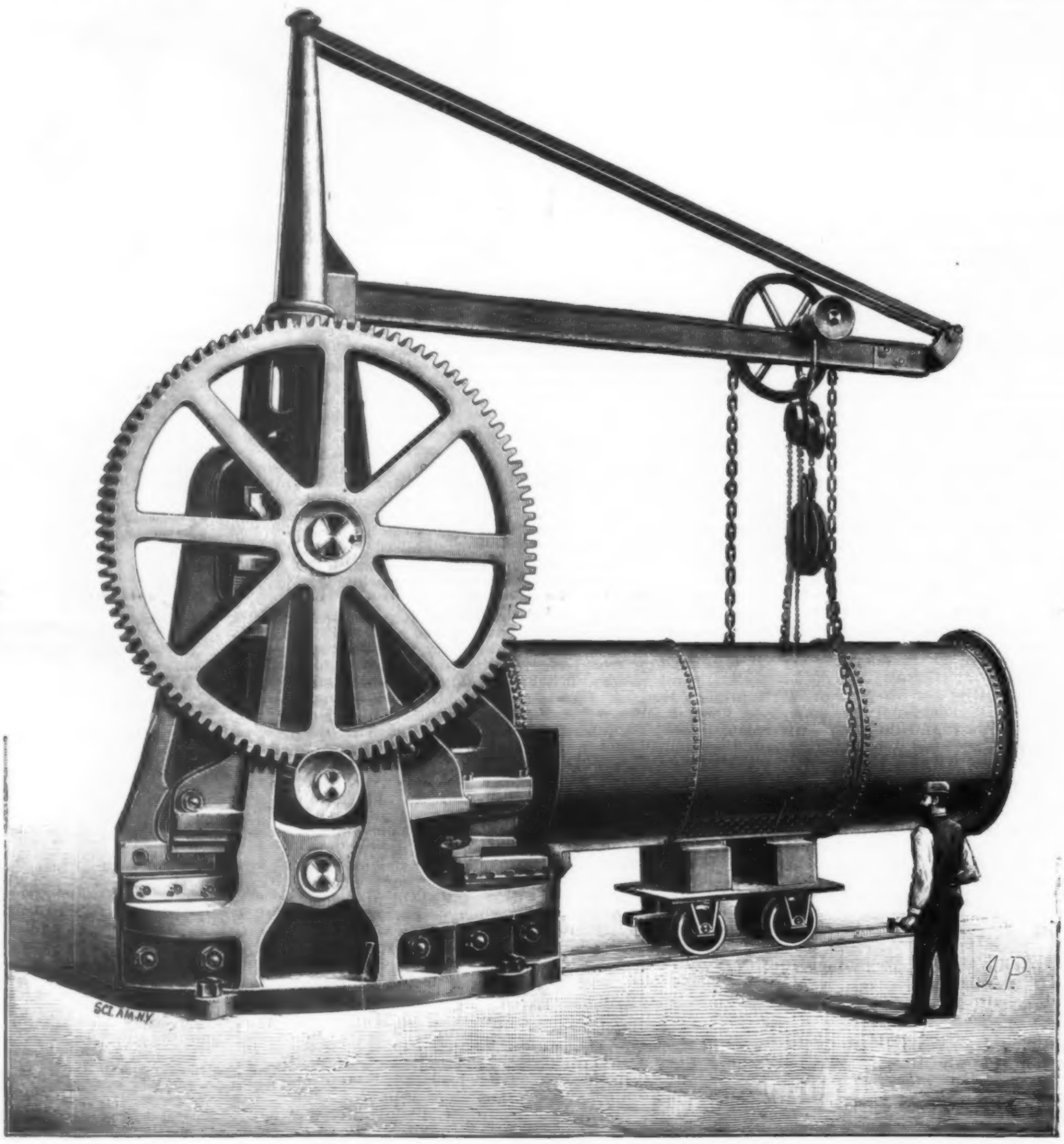
woolen cloth, which is dipped in water just enough to wet it. Too much force should not be used in rubbing for fear of cutting through the enamel. After it has all been rubbed down to an even surface, with no rough places, hairs, etc., the work is thoroughly washed off to remove the pumice stone. After it has dried, the second coating should be applied the same as the first. The enamel used by the writer is in a separate tin for each coat.

Care should be taken that no dust settles on the work. After having baked as before, the work should be rubbed down, this time with ground rotten stone, which is much finer than pumice stone and cuts much slower. This coat should be rubbed down to an even surface. If the first coat has been rubbed down properly, this coat will only require the polish removed. Hair or moss may be used instead of rotten stone on the second coat. After washing off the rotten stone, apply the third and finishing coat. This is the polishing coat, and if the previous coats have been rubbed to a smooth, even surface, the polish will be all that can be desired. This coat is not to be rubbed. Striping can be applied after the last coat is on and baked, but it will not require an extra baking. The writer finds that it pleases his customers to have the names of the owners painted on and baked. By being careful, as well appearing a frame can be obtained as if it had been dipped, as is usually done at the big enamelers. It should be applied in a moderately warm room free from dust and later in the oven, as the heat will create a circulation of dust which will settle on the work and a rough frame will be the consequence.—O. A. Jarboe, in Cycling Life.

SPECIAL SHEARING MACHINE.

THE present method of cutting up old locomotive boilers has always been regarded as a very slow and unsatisfactory process, and it will, therefore, be interesting to our readers to give a few details respecting a new shearing machine which is being introduced by Messrs. De Burgue & Co., Limited, Strangeways Ironworks, Manchester, by means of which the time and cost of the above operation are very largely diminished. The working of this shearer, which will be readily understood from the accompanying illustration, for which we are indebted to The Engineer, may be briefly described as follows:

The boiler shell to be operated upon is conveyed on a trolley to the machine, and the front end is passed between specially arranged cutters in such a manner that when the machine is in operation, with the cutter making eighteen to twenty strokes per minute, each stroke cuts from the boiler a strip 12 in. by 3½ in., the boiler being turned round in its sling chains as the work proceeds, and pushed forward 12 in. each time a ring of strips is cut away, the seams, covers, and riveted joints being taken indiscriminately. The bottom cutters take the form of a die having two sides and one end. It is open at the back end. The top cutter is a solid block about 12 in. by 3½ in., a sort of cutting punch cross cutting the strips at the end of each stroke. When the boiler shell has been entirely cut away the scrap is shoveled down a shoot, where it is weighed and put into trucks. The machine is at present working at the Lancashire and Yorkshire Railway Company's Horwich Works, where three men operating this shearer are able to cut up one large steel locomotive boiler per hour throughout the day, and clear away the scrap, whereas in the old method two men could only do the same work in three days; while another advantage of the new arrangement is that the pieces when once cut are immediately ready for piling in the wall furnaces, instead of having to be again cut, as is usually the case. The cost per boiler is, we understand, only 10 per cent. of that incurred with the ordinary mode of cutting, while the work is much more satisfactorily performed. The arrangement at the left-hand side of the drawing shows the method adopted for scrap cutting, steel rails, tires, etc., the cutters at each side, which are 21 in. long, being made of this form, if necessary, with a 6 in. opening at the front, or at one side they may be placed parallel to the axis of the machine for greater convenience in dealing with plate scrap. The total weight of the machine with its engine and crane is 26 tons.



SPECIAL SHEARING MACHINE FOR CUTTING UP LOCOMOTIVE BOILERS.

THE PRESENCE OF SODIUM IN ALUMINUM.

IN the Comptes Rendus de l'Academie des Sciences, Paris, Henri Moissan, the eminent French scientist, gives some interesting results of experiments he has made recently, regarding the presence of sodium in aluminum prepared by electrolysis. M. Moissan has already shown in former experiments that small quantities of nitrogen and carbon in aluminum reduce its tensile strength. Recently he has found that the presence of sodium is not at all unusual, and is very detrimental. The analyses were effected by digesting in an aluminum vessel 250 gm. of metal, in the form of filings, with 300 c. cm. of water distilled in an aluminum retort. After continuing the process for a fortnight the liquid was filtered and found to be slightly alkaline. Further treatment with hydrochloric acid gave a substance possessing all the characters of sodium chloride, and amounting to from 0·1 to 0·3 per cent. of the metal employed. Other chemists have also detected sodium in aluminum. Moissonier in particular having found as much as 4 per cent. in one sample. Aluminum containing sodium is attacked by water, at first slowly, but afterward with increasing rapidity, especially if the quantity of water is small. This is due to the successive formation and decomposition of aluminate of soda. The source of this impurity is considered by Moissan to be the cryolite used in the extraction of the metal. It has been stated by Richie that an alloy of aluminum and tin decomposes water at the ordinary temperature. This was not the case of an alloy prepared by Moissan with six per cent. of tin and 94 per cent. of aluminum free from sodium, the action of water on it being to form the oxide slowly, without any evolution of hydrogen. Alloys with tin are, however, not suitable for soldering aluminum, which should be used as far as possible by itself, and not in contact with any other metal. The presence of impurities of any kind, he says, seriously affects its durability.

THE ACTION OF ELECTRIC CURRENTS ON MINE SURVEYING INSTRUMENTS.*

IN view of the rapid increase in the number of electric railways in the Westphalian coal field and in the use of electric power under ground, the question of the action of electric currents on magnetic mine surveying instruments is of such great interest that the author has been induced to conduct a series of experiments. A point, underground, was selected at a horizontal distance of some 100 yards from the rails of the Bochum Herne electric railway, and 434 m. (1,420 ft.) below it. There, by means of a Fennel's magnetometer with quartz fiber suspension, a series of observations of variation were made based on a fixed line. The magnetometer was previously compared for a long period with the apparatus in the Bochum Town Park, and the two instruments were found to coincide almost exactly. The first observation, in September, 1895, was made by day, the second by night, when the line was free from current, and the last again by day. While the curve of the day results exhibited great irregularities, that of the night results was perfectly regular and in accord with the magnetic records. The irregularities in quite small intervals of time amounted to from 2·7 minutes to 5·4 minutes. As at first it was thought that the deviations might be ascribed to the iron-free safety lamps employed, a third observation was made in the morning, the lighting being effected by a stearine candle. The results were exactly the same as on the first day. As the observations were made at a comparatively large distance from other workings, and as the shaft was 200 yards away, it is evident that magnetic observations can, under such conditions, be only satisfactorily conducted during the night in the absence of

* By W. Lenz. Abstracted from Gluckauf for the Institution of Civil Engineers, Great Britain, by the Colliery Engineer.

the magnetic current. Another source of error is the safety lamp. Composed of various metals, the lamp in a hot condition sets up thermo-electric currents which act on the magnetic needle. In order to obtain information on this point, the author placed six mine surveyors' safety lamps free from iron, one at a time, first in a cold condition, then heated, at the pole of a sensitive magnetometer. Of the six lamps examined, two, when cold, had no action on the needle, while all acted on it when hot. The deviations observed amounted to from 30 seconds to 160 seconds. A new benzine lamp, that had not previously been used, caused a deviation of as much as five minutes. The deviation increased with the temperature of the lamp. A quite new aluminum safety lamp caused the same deviation when cold as when hot. From these results it follows that the mine surveyor, before making magnetic observations with delicate instruments, should carefully test his lamp. The influence of slight magnetic properties may be lessened by holding the light in the prolongation of the magnetic axis. With side lighting great care is necessary.

ELECTRIC FURNACES AND THE CONVERSION OF CARBON INTO GRAPHITE.

M. MOISSAN's experiments upon the diamond, two to three years ago, directed attention to electric furnaces. Since that epoch, a few new industrial applications, such, for example, as the manufacture of carbide of calcium, have supplemented laboratory experiments.

Messrs. Street and Girard are now proposing to use the electric furnace for converting artificial carbon into graphite. In a recent communication to the International Society of Electricians, Mr. Street passed in review the principal models of furnaces that have hitherto been applied in the industries, and made known the results that he and his coadjutor have obtained.

We have thought it would prove of interest to give a résumé in this place of the principal parts of his communication.

In certain furnaces the heat is due to the electric arc, while in others it is produced by the incandescence of a resistant portion of the circuit formed by the materials to be treated. In the first case, the substances that it is desired to heat may be placed at one of the electrodes or in the vicinity of one of the arcs. The latter arrangement alone permits of separating the calorific action of the current from its electrolytic action. With the others, this result can be obtained only by applying alternating currents.

It was at the Exposition of Electricity of 1881 that were seen the first models of electric furnaces, patented by the Messrs. Siemens, in 1879, and by Mr. L. Clerc, in 1880, and both of which utilized the heat due to the electric arc.

The Siemens furnace (Fig. 1) consists of a carbon cru-

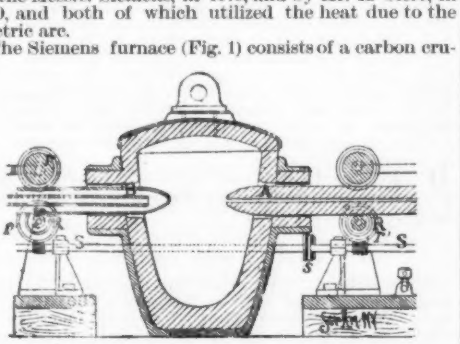


FIG. 1.—SIEMENS ELECTRIC FURNACE.

cible provided with two opposite apertures that permit of the passage of the two horizontal electrodes, A and B. The anode, A, is always of carbon. The cathode, B, may, if need be, be formed of a metallic piece cooled by a circulation of water. These two electrodes approach each other automatically in measure as they wear away, owing to a special arrangement. The substance to be heated is placed at the bottom of the crucible. A carbon cover prevents the loss of heat.

For good conducting substances, another arrangement was used. The substance, placed at the bottom of the crucible, received the current through a platinum screw and served as a positive electrode. The negative electrode, cooled by a circulation of water, was placed vertically in the center of the cover.

The Clerc apparatus consisted of a crucible of magnesium or limestone traversed by two horizontal electrodes.

The majority of the furnaces devised since the epoch have been applied to the extraction of aluminum. As long ago as 1885, the Cowles brothers employed for the reduction of the ores of zinc, aluminum, silicium, etc., a furnace arranged in such a way as to raise the materials to incandescence. It consists of a cylinder, A, a bad conductor (Fig. 2), surrounded by a layer, B, of a

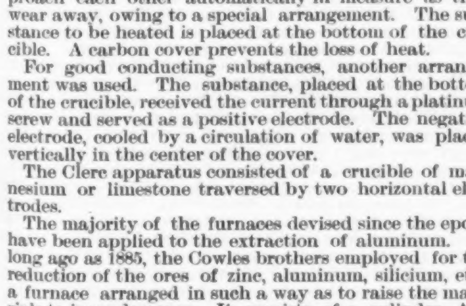


FIG. 2.—COWLES BROTHERS ELECTRIC FURNACE.

but slightly conducting substance, such as powdered charcoal. One of the extremities was closed by a carbon disk, C, forming the positive electrode, and the other by a graphite crucible, D, constituting the negative one. The mixture to be treated (ore and carbon) was introduced through an aperture left by the crucible, which, in the case of zinc ore, served at the same time as a condensation chamber for the vapors of the metal

The Messrs. Cowles afterward (in 1886) employed a furnace of fire bricks lined with carbon. The electrodes, horizontal or slightly inclined, were at first placed quite near each other, and then progressively separated in measure as the resistance diminished.

Finally, a little later on (in 1887), the same inventor made use of a continuous furnace (Fig. 3).

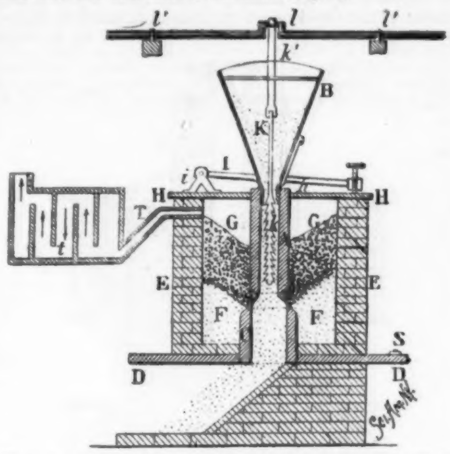


FIG. 3.—COWLES BROTHERS CONTINUOUS ELECTRIC FURNACE.

The electrodes, positive and negative, were formed of carbon tubes, A and C. The mixture to be treated was placed in the hopper, B, flowed through the tubular electrodes and made its exit at the lower part. The anode was capable of sliding freely through the orifice, h. Its distance from the cathode was regulated by raising the lever, I (movable around the axis, i), more or less by means of a screw. The walls, E, were of fire brick and bricks of silica. A filling, F, formed of carbon or a mixture of lime and carbon isolated the negative electrode, C, from an electric and calorific standpoint.

A second filling, formed of coarser grains, surrounded the zone of fusion, while at the same time permitting the gases to escape through T, in order to reach the condenser, t.

Messrs. Rogerson-Statter and Stevenson were the first (1886) to employ electromagnetic action for directing the electric arc. Upon placing the furnace between the two poles of an electro-magnet whose polar expansions are movable, it is possible, at will, to deflect the arc toward the top or bottom of the internal cavity.

In the Bernard brothers' furnace (1887), the current intervenes only for finishing the heating. The carbon crucible, placed in the interior of a second crucible of refractory material, serves as a positive electrode. The negative electrode is vertical. Beneath the external crucible there is a grate upon which is placed the fuel for the beginning of the heating. The negative electrode is afterward lowered until it comes in contact with the materials to be treated.

In the same year Mr. Heroult patented a furnace designed for the manufacture of aluminum, and placed like the preceding above a fire place. The principal crucible, a (Fig. 4), is surrounded by a second crucible,

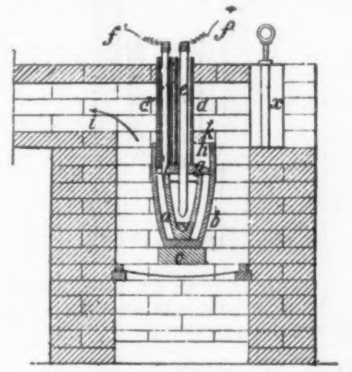


FIG. 4.—HEROULT ELECTRIC FURNACE.

b, of graphite. It is connected with the negative electrode, e, and closed by a cover, g, traversed by the positive electrode, e. These two electrodes are of carbon. The entire system rests upon a support, c, placed above the grate of the furnace.

The Readman furnace (1888) is, on the contrary, designed for the manufacture of phosphorus. It is constructed of refractory materials and contains two in-

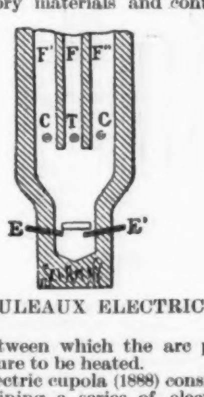


FIG. 5.—THE REULEAUX ELECTRIC CUPOLA.

clined electrodes between which the arc plays in the vicinity of the mixture to be heated.

The Reuleaux electric cupola (1888) consists of circular masonry containing a series of electrodes, E E' (Fig. 5). Above this common heating chamber the apparatus is divided into three compartments, F F' F'', provided with tuyeres, C T, that permit of heating the materials before they reach the zone of action of the electric arc.

In 1889, Mr. Kiliani conceived the idea of giving the positive electrode a pendulum motion, circular or conical, in order to prevent the formation of a solid crust upon the surface of the bath in fusion.

In order to diminish the wear of the anode in mixed furnaces, Mr. Willson (1890) formed this electrode of a vertical tube of carbon, into which passed a jet of hydrogen, illuminating gas or other hydrocarbon. This apparatus was used especially for the manufacture of aluminum bronze.

The same year Messrs. Schneller and Astfalck, for the manufacture of aluminum, employed a tension of 20,000 volts, produced by secondary generators. It is thus possible to overcome the bad conductivity of the materials to be treated, and a wide surface may be offered to the hydrogen or hydrocarburets used for effecting the reduction.

In 1892 Mr. De Laval utilized for melting metals the heat produced by the passage of the current through a slightly conductive material in a state of fusion.

Fig. 6 shows the arrangement employed when the

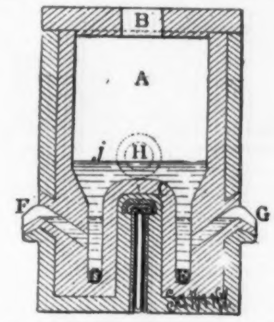


FIG. 6.—THE LAVAL ELECTRIC FURNACE.

metal is denser than the electrolyte. The two electrodes, D E, placed at the lower part are covered by the metal. The circuit is closed through the electrolyte that covers the bridge, C, of refractory material. The metal to be melted is introduced through B and flows out through the orifices, F and G. The excess of electrolyte makes its exit through H.

In 1893 Mr. Chaplet patented an electric furnace constructed according to the Moissan system. A block of fine grained stone (Fig. 7), as free as possible from

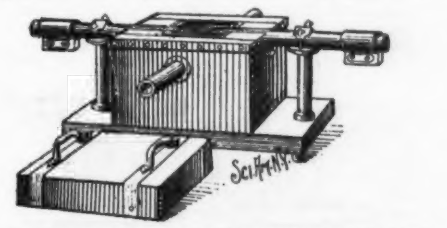


FIG. 7.—THE CHAPLET ELECTRIC FURNACE.

silica, presents a rectangular cavity and forms the external jacket. The walls of the internal cavity are lined with alternate plates of magnesia and carbon. Another block of stone serves as a cover.

A tube of carbon, the diameter of which may vary from 5 to 40 millimeters, traverses the apparatus at right angles with the electrodes, which are horizontal. It is arranged at one centimeter below the arc and one centimeter above the bottom of the cavity. This tube, which is to contain the bodies under experiment, may receive a facing of magnesia if it is desired to protect the body against the direct action of the carbon.

Finally, Messrs. Street and Girard have, for the last two years, been constructing several styles of electric furnaces for the purpose of converting artificial carbon into graphite.

Fig. 8 represents a furnace designed for the heating of materials in the form of rods, bars, or filaments.

The operation is continuous. The bar to be heated receives a shifting motion through rollers actuated by an electric motor, so that all its parts successively traverse the furnace, and consequently undergo an identical treatment.

This furnace consists of a block of refractory material, a, covered by a metallic jacket, b, and presenting at its center a heating chamber, c. This chamber is traversed by the bar, e, and receives, through another orifice, the electrode, d. The arc forms between this electrode and the bar, which receives the current through the rubber, o. As this latter has a sideways motion,

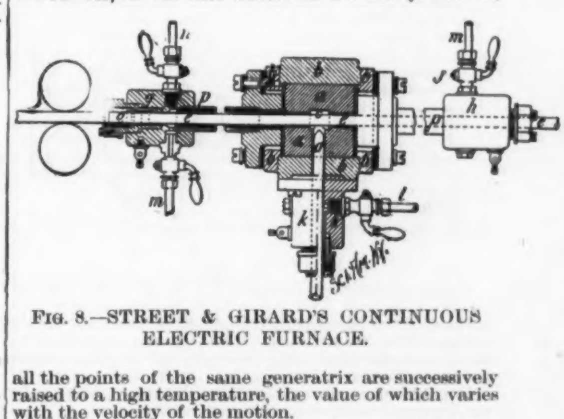


FIG. 8.—STREET & GIRARD'S CONTINUOUS ELECTRIC FURNACE.

all the points of the same generatrix are successively raised to a high temperature, the value of which varies with the velocity of the motion.

When the heating is to be done in a special atmo

sphere, the tightness is assured by means of stuffing boxes, g, h, k, which are traversed by the extremities of the bar and of the carbon, d. At l and m may be seen the entrance and exit orifices of the gas. At n there is a connection for a pressure gage. Before undergoing the action of the arc, the piece, e, traverses a chamber, p, where it is submitted to the action of the gas. After passing into the cavity, c, it becomes cooled in another chamber before making its exit. In most cases, the piece, e, is submitted to the simultaneous action of two arcs placed in series, for which it serves as a common electrode.

When it is desired to treat pulverulent materials, they are inclosed in a tube of a proper nature, according to the temperature that it is desired to reach.

In certain cases, instead of causing the material treated to move along with the receptable that incloses it, it is preferable to set it in motion in the envelope itself, which remains stationary. Messrs. Street and Girard then employ the furnace shown in Fig. 9. The

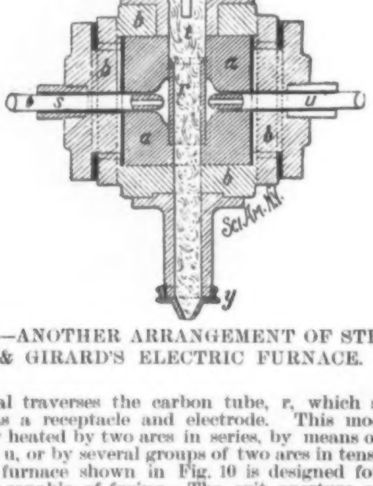


FIG. 9.—ANOTHER ARRANGEMENT OF STREET & GIRARD'S ELECTRIC FURNACE.

material traverses the carbon tube, r, which serves both as a receptacle and electrode. This model is usually heated by two arcs in series, by means of carbons, s u, or by several groups of two arcs in tension.

The furnace shown in Fig. 10 is designed for substances capable of fusing. The exit aperture, z, is so

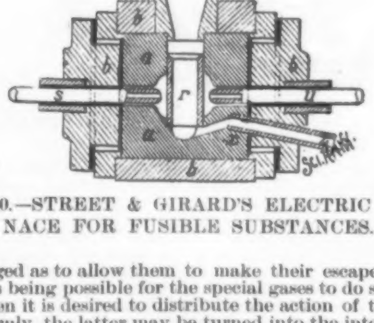


FIG. 10.—STREET & GIRARD'S ELECTRIC FURNACE FOR FUSIBLE SUBSTANCES.

arranged as to allow them to make their escape without its being possible for the special gases to do so.

When it is desired to distribute the action of the arc uniformly, the latter may be turned into the interior of the furnace under the action of a proper magnetic field. The furnace for tubes then receives as electrodes one or more carbons, s (Fig. 11), provided with an aperture concentric with the bar, e. A winding arranged around the external tubes of the furnace determines a field at right angles with the direction of the current element represented by the arc that plays between the bar, e, and the apertures of the carbons, s. Under this action, the arc turns around the bar in a plane at right angles with its axis with a velocity that depends upon the intensity of the current and that of the field.

If the velocity is slow enough, all the points of the

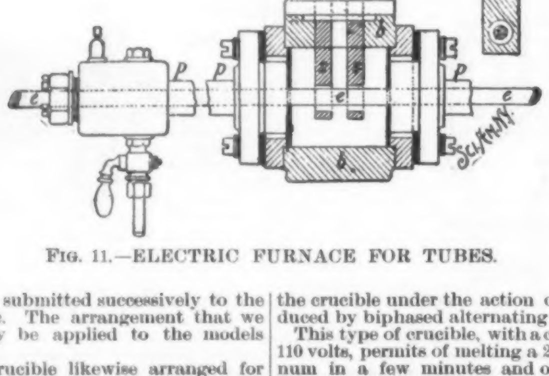


FIG. 11.—ELECTRIC FURNACE FOR TUBES.

surface of the bar will be submitted successively to the action of the electric arc. The arrangement that we have just described may be applied to the models shown in Figs. 9 and 10.

Fig. 12 represents a crucible likewise arranged for producing a rotation of the arc.

The furnace consists of three blocks of carbon, a, b, c, placed in the interior of a block of properly selected refractory material, such as silica, magnesia, etc. Two refractory plates, f, h, complete the apparatus, which is placed in a metallic cylinder closed at its two extremities by plates, i and j, of the same nature, from which it is separated by isolating joints.

The carbon crucible, v, is suspended in the center of the furnace by its flange, which rests upon a ledge formed in the block, a. It is pressed against its support by the carbon plug, d, which is mounted in a carbon

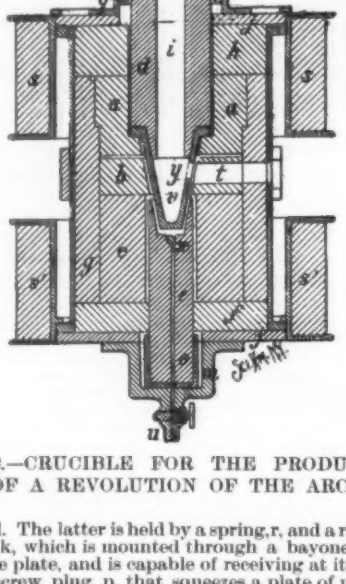


FIG. 12.—CRUCIBLE FOR THE PRODUCTION OF A REVOLUTION OF THE ARC.

carrier, l. The latter is held by a spring, r, and a ring, q, in a piece, k, which is mounted through a bayonet catch upon the plate, and is capable of receiving at its upper part a screw plug, p, that squeezes a plate of mica, p'. This arrangement permits of causing the plug, d, to bear more or less strongly against the crucible. The plug, d, may have a central aperture, i, to permit of observing the reactions produced.

The blocks, c and f, are provided with a conduit that gives passage to a carbon electrode, e, whose extremity envelops the lower part of the crucible, v, without touching it. The arc plays between this electrode and the crucible, which receives the current through d and j'. Two solenoids, s and s', placed at the exterior of the metallic jacket, w, produce a magnetic field which causes the arc to revolve around the crucible. When the material treated is capable of melting, it is made to flow, without interrupting the heating, though the orifice, y, and the channel, t, which traverses the blocks, a, b, and the jacket, w. It suffices to cause the apparatus to swing upon a horizontal axis.

Fig. 13 shows the arrangement employed for heating

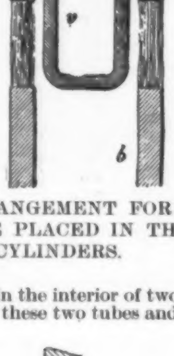


FIG. 13.—ARRANGEMENT FOR HEATING A CRUCIBLE PLACED IN THE INTERIOR OF TWO CYLINDERS.

a crucible placed in the interior of two tubes, a, b. The arc plays between these two tubes and revolves around the crucible under the action of a magnetic field produced by biphased alternating currents.

This type of crucible, with a current of 80 amperes and 110 volts, permits of melting a 25 gramme ingot of platinum in a few minutes and of reducing the oxides of manganese, uranium and vanadium as well as tungstic acid. If the crucible be placed at the negative pole, the metals will be obtained strongly carbureted. If it be at the positive electrode, it will be possible, with certain precautions, to have metals containing but a few traces of carbon.

Messrs. Street and Girard's electric furnaces are especially employed for raising the artificial carbons, such as are now made, to a high temperature. Their conductivity and qualities are thus increased to a notable degree.

If a rod of carbon be passed into the furnace shown in Fig. 8, heated by two arcs in series, in employing a current of relatively slight intensity, there are obtained upon the surface two graphitic generatrices. Upon a carbon of 14 millimeters, with a current of 40 amperes, the width of these generatrices is about 2 millimeters, and the depth of the transformed stratum about 1·5 millimeter. If the temperature rises, the trace left by the arc widens and penetrates more deeply.

At the end of a certain length of time, the carbon treated, which, at the points touched by the arc, exhibited excavations and swellings, preserves its form absolutely, but is converted into graphite throughout its mass. From this moment, the arc no longer presents its ordinary filiform aspect. If alternating currents be employed, the piece treated and the electrodes seem to be the seat of a volatilization of carbon upon their entire surface.

In the revolving arc furnaces, the graphitic trace presents the form of a helix whose pitch depends upon the velocity of the motion. With a proper velocity the entire surface is transformed. The wear of the electrodes is very feeble. It is 5 millimeters in electrodes of 40 millimeters and a current of 300 amperes. In these furnaces continuous currents are employed, and the piece treated is taken as a positive electrode. It is then useless to employ any arrangement for regulating the length of the arc. In furnaces in which the piece passes between two stationary electrodes, alternating currents are used. It suffices to effect a regulation by hand every hour.

It is possible to obtain a temperature high enough to curve a plate of carbon in exerting a pressure upon one of the extremities.

The rapidity of the transformation varies with the composition of the carbon treated. A piece composed of retort coke agglomerated with tar is converted into graphite less quickly than a carbon containing two per cent. of silica or boric acid. The nature of the surrounding medium appears to exert but an insignificant influence. Hydrogen alone seems to slightly hasten the transformation.

The carbons submitted to the action of the electric furnace acquire new properties. The foreign substances that they contain are volatilized or converted into carbides with proportions of carbon that are very high and attackable by acid with difficulty. The conductivity, electric as well as calorific, varies in the proportion of 1 to 4. The resistance to combustion and to the action of acids, as well as the density, likewise increases.

On account of these modifications, the electro-graphitic carbons resist much better than the ordinary artificial ones, and disintegrate much less. They may, therefore, be advantageously employed as electrodes for arc lamps, as anodes in electrolytic operations, or as brushes in dynamos.

Messrs. Street and Girard are now endeavoring to apply the same method to the filaments of incandescent lamps.—Le Genie Civil.

STICKY FLY PAPER.

A GOOD part of the world's supply of sticky fly paper comes from Grand Rapids, Mich., says the New York Sun. There are three or four other small factories scattered about the country, but none of them makes enough to cut much of a figure in the market. The great producer is the single factory in that city, a big concern employing 400 to 600 hands all the year around, and its product is shipped to every land.

The factory is surrounded by a high board picket fence, and guards are on watch day and night to keep out intruders. The best friends of the proprietors meet with as cold a reception, when the matter of going into the factory is mentioned, as any stranger. The sticky preparation with which it is expected the flies will form entangling alliances is prepared by the proprietors personally, and they alone know the exact formula. The preparation is not patented nor copyrighted, as to gain the protection of the government it would be necessary to reveal the materials that go into it, and thus make the formula known to the world and give trade pirates a chance to operate. The secret is protected by not letting it out, and it has been kept successfully for nearly twenty years. The machinery used in the factory is guarded in the same manner against infringement instead of being patented. Most of the machinery was designed for the special purpose to which it is put, and the four brothers engaged in the business made the designs for it themselves and had different parts of it constructed at different machine shops. The fly paper factory occupies four large two-story brick buildings, and the employes in one department are not allowed, under any circumstances, to visit any other department. None but trustworthy men are employed, and once engaged they have substantially a life job; but even the most trusted is not allowed to know more than one branch of the business.

The fly paper is made by spreading certain balsams and gums on a sheet of sized Manila paper. The sheet has a narrow border of wax to prevent the sticky stuff from oozing out. The border of wax is put on, the sticky preparation is spread, and the sheet is folded ready for inspection and shipment by one machine, and this machine has a capacity of about 50,000 sheets a day. From the machine the sheets pass to inspectors, who see that the stuff is of the right consistency, and then to the packers, to be put into boxes for shipment. The paper goes to Africa, Asia, Europe, Australia, and South America, besides all parts of this country.

The manufacturers of the sticky paper began business about twenty years ago on a small scale, occupying a lean-to in connection with a suburban drug store which the brothers had established as a branch of their city business. One of the brothers carried on the fly paper manufacturing as a side issue, and at first only enough was manufactured to supply a limited local demand. The demand gradually grew, and the factory is now one of the big institutions of the city, and the four brothers all devote to it their entire time.

Some time ago the brothers had occasion to discharge

one of their employes, a man who had been with them several years and had unusual facilities for learning the inside of how everything was done. It was suspected that it was his intention to sell the secrets of the manufacture of fly paper, or such of them as he possessed, to a rival manufacturer doing business on a small scale in another town. The brothers immediately brought suit against him by injunction to restrain him from telling what he knew, and from himself engaging in the business. The suit has n t yet been decided. It involves a question of law never yet adjudicated in this State, and one that is specially interesting to manufacturers and attorneys.

TELESCOPIC PHOTOGRAPHY FOR AMATEURS.

By JOHN MILLS, F.R.A.S.

IT is possible by extremely simple appliances to do good work in celestial photography, even to photograph the sun and so make a valuable and continuous sun spot record. This work, however, demands careful manipulation, and especially is this the case when a telescope is employed without an arrangement for keeping the image always in the same part of the field of view. The earth, owing to its rotation on its axis, causes an exposure of but short duration to impart a trailing effect which renders the picture absolutely worthless, and it is, therefore, necessary to ascertain by trial the time of exposure which may be given without detracting from the value of the results obtained.

The aim of this brief sketch is to indicate to such readers of The Photogram as desire to extend their practical knowledge of photography to extra-terrestrial objects, how they may begin the new departure by the aid of apparatus which is cheaply obtainable, or may be constructed at a small outlay and the exercise of a little mechanical ingenuity. The accompanying figures represent the appliances actually employed by the writer some years ago in a series of experiments conducted with the view of ascertaining the simplest means of photographing celestial objects. The telescope (Fig. 1) is a home made instrument, the tubes

FIG. 1.

and cells for the lenses being formed by rolling brown paper smeared with thin glue on to wooden rollers of transverse sectional areas corresponding with the lenses employed. These tubes, made for carrying rolled papers safely through the post, may be obtained from any good stationery warehouse. They can be easily cut with a fret saw; or equally well, though not so easily, with a pocket knife. The lenses, which may be purchased for about four or five shillings, constitute the only item of expense worth mentioning. In this instrument the object glass is of two inches aperture, and the eye piece, Huyghenian or negative, and of that simple form known as the astronomical telescope. Fig. 2 shows a method of fixing the object glass, C, in the tube, A¹, by means of cardboard rings, BB. Fig. 3

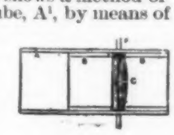


FIG. 2.

FIG. 3.

represents the compound eye piece formed of a one inch focal length lens, E, and a three inch focal length lens, F, fixed by cardboard rings, BB¹R, at the mean distance of two inches apart, the focus of the eye piece being about the diaphragm, D. It is of sufficient space penetrating power to show Jupiter's moons, Saturn's rings, the phases of Venus, resolve double stars, and greatly augment the number of stars seen by the naked eye in clusters such as the Pleiades, while the details on the moon's surface—hill and dale, mountain and chasm, light and shade—are brought out with gratifying clearness.

The length of the main tube will depend upon, and should be rather less than, the focal length of the object glass employed. If this element is unknown, the amateur may readily determine it for himself by holding it up to the light in front of a sheet of cardboard till a window or other object forms a clearly defined image thereon. The distance of the lens from this ex-

FIG. 4.

temporized screen is the focal length of the object glass. The two inch lenses supplied by Sharland may be of different focal lengths, for example, 40 inch and 27 inch, the latter being preferable because the shorter length tends to greater stability when the telescope is mounted on a tripod stand. The focus is roughly adjusted by an adapter, D, Fig. 4, which slides in the main tube, and the eye piece is movable for finer adjustments in the tube, A, firmly fixed by the diaphragm, B, and flange, C. This adapter, or drawing tube, should be about 10 inches long, so as to admit of focusing objects at varying distances.

Any form of telescope, however, which comes to hand will answer the purpose equally well, and the tripod stand of an ordinary camera may be readily adapted to support the instrument; which must be so arranged as to admit of motion in two directions—up and down and to and fro, or, as the astronomers would say, in altitude and azimuth. Fig. 5 indicates the way

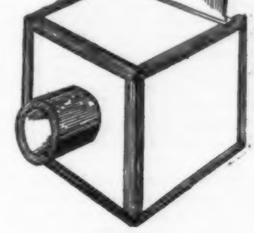


FIG. 5.

in which an auxiliary piece may be constructed for use with the ordinary tripod. The shoulder, S, admits of rotation of the vertical rod, R, in azimuth, and the thumb screw, T, is capable of retaining the V-shape groove, G, at any angle, so that the telescope supported in the groove may thus sweep the heavens in altitude.

All that is requisite in the way of a camera may be constructed out of a cigar box, the joints being bound round with thin leather, as indicated in Fig. 6, to ren-

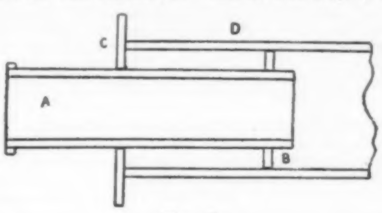


FIG. 6.

der the chamber light tight. The little cubical box (about 3½ face) thus formed may be attached to the eye end of the telescope by means of an adapter in the form of a tube made of brown paper and of a diameter suited to the telescope in conjunction with which it is intended to be used. The dark slide, of course, is of the ordinary kind, in miniature, and the plates may be obtained by slicing up quarter plates into two or four pieces.

From what has already been said, it will be seen that when a telescope is used for photographic purposes, the sensitive plate replaces the eye and receives the image of the distant object. Further, there are two methods of taking pictures of celestial objects. (1) The object glass of the telescope may be used alone for forming images, that is to say, the principal focus of the instrument where the picture is smallest and most sharply defined, and (2) the eye piece may be employed as a secondary magnifier in conjunction with the object glass. In this case, however, the image, though large, is not so satisfactory, and it is, therefore, better to enlarge in the usual way from the negative obtained by the object glass alone.

It is important in attempting the photography of celestial objects with a telescope to bear in mind that the lenses of ordinary instruments are not corrected for the actinic rays, and consequently the images received in the glass screen when in focus will not correspond with the focus of the chemically active rays. The amount of adjustment for this source of error can only be found by trial, and the initial efforts of any beginner in celestial photography will probably be attended with disappointment arising mainly from this non-coincidence of the two kinds of light rays named.

The sun's light is so intense when focused that it is very difficult to avoid over-exposure. We must, therefore, reduce the light by the use of cardboard diaphragms placed over the object glass, the aperture being thus reduced to about half an inch. An ordinary felt hat may be used for exposure in lieu of a cap. Better than this is a simple flap of cardboard, covered inside with black velvet, which may be hinged to the end of the telescope, and, if desired, supplied with a spring of elastic to insure its quick closing. The length of exposure in the case of the sun must be as brief as the operator can possibly make it. In this way the time of exposure may be controlled so as to render the problem of photographing the sun eminently practicable. It may still happen, however, that instead of a negative image a positive one is obtained. It is best to attempt the moon when about four or five days old, because then the rugged outline between light and shade, and the shadows in the craters are such distinct features. Several photograms may be taken on one plate by tilting the instrument slightly in the interval between successive exposures. In the case of the moon it will be necessary to give an exposure of about five seconds, sometimes less, but generally more. A few preliminary shots, however, will do more than a multitude of words in paving the course of the amateur in this branch of photography. I need hardly say that very rapid plates should be avoided, and medium or slow plates used.

Many years ago De la Rue and Rutherford, the pioneers of celestial photography, produced exquisite photograms of the moon. They first obtained a small picture about one and a half inches in diameter, and afterward enlarged it to—in some cases—about three feet. In our modest instrument, the negative will be little more than a quarter of an inch in diameter.

At the present time what is known as the sun spot minimum is not far off, and the spots are not so plentiful as they were a year ago. Nevertheless, there are nearly always some of these interesting objects visible on the sun's disk, and those who care to do so may fix them on the sensitive plate.—The Photogram.

THE INVISIBLE FOOD OF FISH.

RECENT experiments on the food of the oyster show that the oatmeal commonly given to "fatten" them causes them to lose weight and die, and that flour, often used for the same purpose, soon poisons them, though, on the other hand, the typhoid bacillus is destroyed by passing through the oyster's alimentary canal. The latter discovery will be good news to the owners of oyster beds. But the study of bacteriology is a new one. What strikes the average reader as more curious is the lateness of the discovery that the food commonly used in shops, in England, to fatten oysters disagrees with and kills them. Yet it is only one of the results of what, until recently, was a very general ignorance of the main food supply, not only of shell fish like the oyster, but of all the swarming vertebrate fishes of the sea, except such as are entirely carnivorous and live by preying upon other fish. The food of river fishes was better known; but what was, until recently, thought to be their principal food now appears to play only a limited part in their maintenance, and the common fisherman's view, that river fishes, like robins, live mainly on worms and grubs, with a change to May fly in the season, and occasional feasts of ground bait and paste, is almost as far removed from fact as the showman's description of the elephant's diet as consisting mainly of cakes and hay.

But the case of the river fish did not settle the obvious problem suggested by the question of the food supply in the sea. The sea, except in the shallow water fringe along the shore, is devoid of vegetables. It contains in general no growth of weeds and plants to harbor swarms of possible food creatures with their eggs and larvæ, and where such vegetable growths do occur, as in floating weeds of the Sargasso Sea, a race of fish and crustaceans at once appears, limited to that locality, and obviously fed from that source alone. Neither does the sea, except in certain areas, greatly abound in vertebrate fish. You may catch large fish at any point on the voyage in the narrow seas, from Gibraltar down the Mediterranean to Aden. But the open seas are not full of the fry of fish which might form a good supply for others, and in the Atlantic, except on the Newfoundland banks, there are no fish found near the surface at all. A bucket of Atlantic water is to the eye simply a vessel of transparent brine, unfouled with weed, void of fish, and, in most cases, not visibly infested with any form of floating marine organisms. Yet at any moment shoals of fish numbering millions of individuals may elect to enter this apparently foodless waste; the herring shoals disappear into the deep Atlantic and return in good condition, oily and exuberant, and the whales find sufficient food to make them the "fattest" creatures in creation.

. . . .

The cyclops will, it is calculated, beget four hundred and forty-two thousand young in the course of a year, and the cetochilus, or "whale food," is said, even in the Firth of Forth, to form almost exclusively the food of the herrings and the sea-living salmon and salmon trout. Their existence is one of the greatest economic triumphs of nature. They are the creatures which dispose of the refuse of the world in the sea, and keep it sweet. Dead vegetable and animal matter feed these entomostraca, and they are converted without further machinery into the food fishes of the world, or at one remove, when these are eaten, as food for other fish, such as the tunny, the cod, and the mackerel, which follow the herring shoals. Nothing short of assimilation in the digestive organs of fish seems to kill these entomostraca. They swarm in the distilled brine of the salterns on the Solent. Their eggs are proof against frost, and survive being baked by the sun. They even come to life without being fertilized. Yet they undergo infinite changes of form, and their cast shells are piled like billows of dust on parts of the Cornwall coast. Detached and self-supporting, they wander over the whole ocean, swimming mainly upon the surface. At times they descend to the deeps, and this, it is surmised, causes the temporary disappearance of fish which necessarily follow them. Their countless numbers are also recruited by the microscopic larvæ of fixed shells. The barnacle, for instance, begins life in this form, taking its place in the ingredients of the "sea soup" as a one eyed swimming crustacean, then growing a pair of eyes, and finally settling down as a fixture in proper barnacle style.

In rivers they are almost the sole food of all young fish, and probably the main resource of the older fish when other supplies fail. In the first days of spring the creatures in every stage, eggs, larvæ and perfect, though microscopic, entomostraca, swarm in the water, on the mud and on the foliage of the water plants. At such times even trout feed mainly on them. In the Hertfordshire streams the trout are then said to be "tailing." They push their heads down into the weed and raise their tails, which wave about in the weeds or even above the surface of the water. They are eating the weed bare of the clinging film of microscopic larvæ, of water fleas, cyclops and other fresh water entomostraca. The trout is the most easily fed of all fish, being greedy, omnivorous and not afraid of artificial food, such as bread or paste. But the kind of food with which it is supplied makes a vast difference in its growth. Experiments made on trout showed that when fed upon worms only they grew slowly; others fed on minnows did better, but a single fish fed upon insects weighed twice as much at the end of the experiment as a pair of those reared upon worms and minnows respectively.—Spectator.

Cockroach Exterminator.—A writer in a German agricultural journal states that poke root is deadly to roaches, and gives the following formula for a poison that will destroy these pests: Extract 60 to 80 grammes of poke root with a liter of water by boiling, strain, and mix the extract with sirup (molasses will answer), and spread on plates in the places most frequented by them. The same writer suggests powdered borax as an effective poison for roaches.

ENGINEERING NOTES.

According to our San Francisco contemporary, the Journal of Electricity, a wave motor installed in a bay at Capitola is running in good order and is developing as high as 180 horse power.

The Pittsburg Reduction Company has put into successful operation the new rolling mill at Niagara Falls. At this mill the company is able to roll aluminum sheets 72 inches wide, and is now working on some orders for sheets 60 inches in width. Heretofore their mills near Pittsburg had a capacity for sheets of 30 inches only.

The expedition of Russian engineers and soldiers, sent from Siberia to China, has, it is stated, nearly finished the survey for the branch of the Siberian line which is to run through Chinese Manchuria, and will materially shorten the distance to the sea. Official Russian reports concerning the progress of the Siberian Railway up to the beginning of this year are very favorable.

The tunnel under the Hudson River at New York, which was partially built several years ago, has been closed up for over three years, and no work has been done upon it. The tunnel is the property of an English company, the Hudson Tunnel Railway Company. At a meeting of the bondholders in London, June 11, it was voted to foreclose the mortgage and turn the property over to a new company, which will raise the money necessary to finish the tunnel.

A novel and very interesting application of a lubricant, says the American Machinist, has recently been made to armor piercing shells which have been made at Spuyten Duyvil, N. Y., with a small chamber near the point filled with graphite. Grooves are provided for distributing this graphite and at the instant of contact the lubricant chamber is broken open, and its contents, spread over the surface of the shell, make it go through plates easily which it would be impossible to pierce without the lubricant.

Forgings for 5 inch rapid fire type gun, for fixed metallic ammunition, manufactured in accordance with designs prepared by Capt. Charles Smith, Ord. Dept., U. S. A., have been delivered at the Watervliet Arsenal and their assembling will begin at once. In addit'on a carriage, the design of Capt. Crozier, Ord. Dept., for this caliber of gun is also under construction. This gun, when completed, will be given an exhaustive test, and if satisfactory results are secured will be the type for about fifteen others for Army service. The gun is 45 calibers in length of bore, and fires a 55 pound projectile, with a velocity of 2,500 feet per second, smokeless powder being employed in the cases.—Army and Navy Journal.

According to Dr. Louis Duncan, the average paying load on the freight trains of the Pennsylvania Railway is about half the total weight of the trains, while on the passenger service the ratio is only about $\frac{1}{15}$ or less. The freight trains in the States are, it is well known, very long, and the weight hauled per engine has been steadily increasing. This has led to a great reduction in the working expenses, which on one large road in 1893 were less than ¼d. per ton-mile. Dr. Duncan thinks that electric haulage is not so well adapted for dealing with this freight traffic as the steam locomotive, since, with the latter, no inconvenience is caused by the concentration of traffic near any particular point, while with the electric system such a congestion would cause the power station there to be overloaded. On the other hand, he holds that the electric system is eminently adapted both for local and express passenger traffic, as there is no objection then in running frequent trains of one or two cars only. This leads to a fairly uniform distribution of traffic over the line, under which conditions the electric system is at its best.

A correspondent of the Centralblatt fur die Textil Industrie, who complains that several belts are dirty from drop oil and dust and desires to know how to clean them, is told by that journal, whose remarks are translated by the Industrial Record, to first wash the belts with warm water and soap, using a sharp, stiff brush, and while still moist, to rub them with a solution of sal ammoniac, which saponifies the oil in them. Immediately thereafter the belts must be rinsed well with lukewarm water and then dried with sufficient tension. While they are still moist the belts are to be rubbed well on the inside and less on the outside with the following unguent: 1 kilo.—2 lb. ¾ oz.—India rubber heated to 122 deg. Fah. and mixed with 1 kilo. rectified turpentine oil. After the solution is complete, 780 grammes—27 oz.—bright resin are added, and when it is dissolved, 750 grammes—26½ oz.—yellow wax are added. This mixture, by diligent stirring, is mixed with 3 kilos.—6 lb. 10 oz.—fish oil and 1¼ kilos.—2 lb. 12 oz.—tallow previously dissolved in the former. In the further treatment of the belt, rub the inside only and the outside only the first time as stated. This unguent also replaces the tannin extracted from the leather, prevents the dragging of the belt, and imparts elasticity to it.

The new road which the Pennsylvania is building from Lilly to Portage will be for passenger trains only, and freight trains will continue to use the present track, says the Pittsburg Post. The passenger tracks will be perfectly straight, so that west bound trains when running late can make wonderful speed records on the down grades with perfect safety. After they reach the summit steam and gravity combined will enable the new and powerful passenger engines to run 100 miles an hour if necessary, but of course the fast time can be maintained for only a short distance. On a down grade, with straight tracks, there is no limit to the speed at which the Pennsylvania's trains may travel. The company will spend large sums of money during the next two years in straightening out the tracks where the descent is favorable for fast time, and by 1898 they can run a train to Chicago or St. Louis in six hours less than on the present fast schedule. On the east side of the Allegheny Mountains the famous Horse-shoe Curve may be some day in the near future abandoned by passenger trains. New tracks will be built down the slope perfectly straight, and the eighteen miles from Allegrippus down to Altoona can then if necessary be run in fourteen minutes, and the fireman will have nothing to do but ring the bell.

ELECTRICAL NOTES.

The State of Ohio has substituted electrocution for hanging. The law went into effect on July 1.

It is said that telephonic communication will be established between London and Nice at an early date.

The scheme for the construction of an electric mountain railway from Zermatt up the Gornergrat will soon be put into operation. The water power of the Findelenbach will be used to generate the current; the line will be about six miles long.

A handsome statue of Benjamin Franklin was recently unveiled at Chicago by Rene Bach, the great-greatgrandson of Franklin. The statue was presented to the printers of Chicago by Joseph Medill, publisher of the Chicago Tribune. It was erected in Lincoln Park.

An eight inch iron pipe one-quarter inch thick with flanges electrically welded on, when tested to destruction at Netherton, England, broke in the body of the pipe at 88 tons, the welded part remaining intact, and a similar pipe of steel broke in the welded part of the flange at over 101 tons. These tests were tensile only and were carried out to prove the absolute soundness and consequent strength of the flanges electrically welded on.

A correspondent of Electrical Industries disputes the statement that the graphite bushing or bearing of trolley wheels generally gives way before the wheel wears out. In Philadelphia, he states, it is found that in the renewal of, perhaps, 5,000 trolley wheels, having a life of from 5,000 to 8,000 miles each, but fifty extra bushings were required; and in many cases the bushings are taken out of the old wheels and put in others, thus frequently enduring the wear of two wheels. The weight of the wheels used is from 2 lb. to 2½ lb.

At a recent meeting of the French Academie des Sciences, M. Moissan presented a note on behalf of M. Tommasi on the subject of a new electrolyzer. In this apparatus the cathode is movable and closed by a metallic disk fixed to a bronze shaft, and capable of revolving more or less rapidly between the two anodes. The disk does not entirely dip into the bath, so that each part of the falling ozone is alternately in the air and the liquid. It is claimed that polarization is avoided, and that the electrical resistance of the bath is largely diminished.

At a recent meeting of the Elektrotechnischer Verein of Berlin, says Electricity, Herr Dolivo-Dobrowolsky showed a new type armature for three-phase motors. The armature resembles a compact and massive drum, the surface of which is provided with a large number of small radially cut grooves parallel to the axis. Into these grooves are pressed copper strips, which extend at both ends over the edge of the drum and are there connected to copper rings. Herr Dobrowolsky states that this construction is electrically equal to the old one of the Allgemeine Elektricitats Gesellschaft, which consisted of laminated iron, through which insulated copper bars are led.

Yet another new method of transforming oxygen into ozone has been devised, and, like so many others, it has been worked out by a Frenchman, says the English Electrical Review. The French seem to be peculiarly susceptible to the attractions inherent in this department of electricity. The apparatus, which has been devised by M. Otto, consists of a rectangular box of wood coated internally with varnish, and standing on an insulating foot. The box contains a series of parallel elements, each consisting of two glass plates having perforations at their one end, and having between them a sheet of aluminum, or other conducting material, stopping short of the perforations, which are arranged alternately at the lower end of one element and at the upper end of the next one. The end plates are only provided with one opening for the entry and egress respectively of the gas to be ozonized. The glass plates are separated by thin strips of asbestos, and the end plates rise above the others, the trough-like space thus formed being filled in with suitable cement to seal the box hermetically. The alternate conducting plates are connected to one terminal, while the remaining plates are connected to the other pole of a Ruhmkorff coil or high tension alternating current generator. The electrical discharge takes place across the spaces between the successive elements, while the current of oxygen to be ozonized flows in a zigzag course through the apparatus.

The position of affairs as regards electricity meters cannot be regarded as at all satisfactory. Doubtless there are a large number in use, and there are inventors and manufacturers who advertise that theirs is "the only reliable one in the market." The value of such statements is, however, pretty well understood. The facts are really that one has to put up with the best that can be obtained, and that best is not by any means all that could be desired. The best mechanicians have tried their hand at the problem, and have attained a certain measure of success after the expenditure of much time and money; but there is still a very great deal wanting. We have more than once been asked to recommend a meter, or meters, which would answer certain reasonable requirements, the meters which have hitherto been tried either requiring too much current to start them, or consuming too much current in the shunt coil, or will not work properly if there are motors in circuit, etc. This is especially the case when alternating currents have to be dealt with, the meters in this case showing a 10 to 50 per cent. error. Very few inventors have tackled the subject of alternate current meters; Lord Kelvin has done so, but his meter is not mechanically perfect. Aron's meter is nearly correct on all inductive loads, but mechanically leaves much to be desired. Periodic integrating meters have not proved a success, nor have clock meters, so that motor meters alone remain for us, and they are not perfect. We hear of meters about to be brought out, or just brought out, which are to meet all reasonable requirements; but our faith in such statements has been so often severely shaken, that we hesitate to accept them, and prefer to wait patiently and in hope while the mighty "time" test goes on and proves the value of what is said. We believe there is money in the matter, but money will have to be very freely spent before success is obtained.—English Electrical Review.

MISCELLANEOUS NOTES.

Dr. Salmon, the 107 year old English physician, has just died at Cambridge. When he heard of the battle of Waterloo, he posted to Dover and crossed to Brussels to care for the wounded. He practically gave up smoking at 90, but drank port to the end.

A queer accident happened near Walsall in England lately, where a canal fell into a coal pit. The canal flowed over the pit, the underground supports of which gave way, letting down the ground above, draining the canal of water, and putting a stop to all traffic.

England was the first country to issue postage stamps and stamped envelopes, the first appearing in 1840. The denomination of the earliest stamp was one penny. The first stamps issued by the United States were placed on sale in 1847, though several years earlier stamps were issued by various postmasters and express companies.

Genuine egret feathers are sold as artificial in London in order to salve the conscience of women who think it wrong to wear bird feathers in their headgear. The Society for the Protection of Birds had shown that the egret or white heron would soon be exterminated, as the feathers must be obtained during the nesting season. Its agents have now proved that the only artificial thing about the feathers sold is that they are split in two, thus making two plumes instead of one.

There is a boom in new companies going on in England. During June the average was four companies floated every day; the capital called for during the first half of 1896 was $406,000,000. Sixty-five millions were for foreign government loans, fifty-five millions for cycling companies, forty-five for breweries, sixty for railroads, and forty-seven for mining companies. Last year the capital applied for during the same period was $260,000,000, in 1894 it was $155,000,000, and in 1893 only $130,000,000.

Mr. Austin Corbin, who was killed a short time ago in New Hampshire, had acquired a herd of fifty buffalo, which he kept in his preserves in that State. It was his intention to lend the animals for an indefinite period to the city of New York, and a plot of eighty acres in Van Cortlandt Park, in the northern (annexed) portion of the city, had been prepared for them, having been surrounded by a fence seven feet high. The plan will be carried out by his representatives, and the herd will be moved in the autumn; the delay being caused by apprehension that change of climate during hot weather might prove pernicious. This measure may avert the threatened extinction of the buffalo, which has now been almost extirpated on the Western plains.

The first horticultural school for women in Germany was opened at Fridenau, near Berlin, in the autumn of 1894, and it will graduate its first class of seven members next fall, says Garden and Forest. One of the graduates will then assume the position of teacher in a similar school recently established at Riga, in Livonia. On the first of October next still another institution of the kind will be opened on the estate of Baroness Barth-Harmating, near Plauen, in Saxony. The courses of study extend over two or three years, and include not only the various branches of horticulture, but also fundamental scientific instruction and such knowledge of business methods as is needed for the successful prosecution of commercial gardening. Emphasis is laid upon the fact that the new work thus made possible for women is suitable for those of the cultivated classes, and not for uneducated or semi-educated rustics.

The bleaching agent of the future, says a writer in one of the textile journals, is hydrogen peroxide, and it is even now considerably used in wool bleaching. The yarn is steeped in a solution of hydrogen peroxide, to which a little ammonia has been added, thereby causing the decomposition of the peroxide into water and oxygen. The latter, being in its nascent state, readily attacks the coloring of the wool, and forms a colorless oxidation product. This is a permanent white, and should tinting be necessary it can be done after the bleaching. The bleached yarn is sometimes washed in acidified water. From time to time various additions have been recommended for the peroxide bath, but with very little or no advantage. The bleaching solution is to be kept alkaline; indeed, the more alkaline the liquor the quicker is the oxygen liberated, hence too much ammonia is almost as bad as too little.

The new safety lamp for mines, operating upon a peculiar principle, is reported as being in successful use in Germany. A peculiarity of this lamp is noted, namely, that it is not closed in any special way, like other lamps, and it matters very little whether or not the workman, disregarding the regulations of the mine, succeeds in opening the lamp, for there is a special arrangement by means of which the flame is extinguished at the same instant. This is explained by there being in the interior of the lamp glass a spring, which is compressed when the upper piece is screwed down, which enables a cap to operate upon the wick in such a manner as to shift it aside, facilitating the lighting of the lamp and afterward the combustion; when the spring is worked in the contrary direction, the cap again operates upon the wick, and the flame ceases the moment the cap comes in contact with the air. The lamp can be lighted without being opened.

Some new and beautiful fabrics are described in the Dry Goods Economist, one of these being the diagonal mohair crepe, a weave of great ingenuity, which results in the production of a novelty combining the use of mohair with the crepe weave—a black piece dye; and, apart from the material used, the feature is a diagonal in two effects. One of these diagonals is a flat stripe, running, as do all diagonals, at an angle across the piece, and situated between the crepe effects, which also run in the same direction; the flat diagonal is used as a binder, and is a necessary structural feature of the fabric, rather than an ornamental one, showing in two narrow floated lines running in the filling threads from end to end of the fabric; the crepe diagonal, however, is of a totally different character and represents a drawn surface showing an irregular tufted effect. These two effects are due to the manner of using the materials that compose the fabric; everything being due to the way the filling threads are manipulated, and to the difference in the twist and the mohair filling and worsted filling.

SELECTED FORMULÆ.

Tanning Sheepskins.—Tanning sheepskins requires time and careful attention to details, but if properly done beautiful mats and rugs result. Cut off all useless parts, remove the fatty matter from the inside, and soften the skin by soaking it an hour in warm soft water. Mix to a paste with a little water (not dissolve), half an ounce each of borax, saltpeter, and Glauber salts (sulphate of soda). Spread this with a brush over the inside of the skin, using it more freely on the thicker portions. Double the skin together flesh side inward, and leave it in a cool place undisturbed for twenty-four hours. Wash it very clean, and apply in the same manner a mixture of half an ounce each of borax and salsoda, two ounces of hard white soap, melted together, but not allowed to boil. Fold the skin wool side out, and leave it in a warm place twenty-four hours. Dissolve a quarter of a pound of alum, half a pound of salt and two ounces of saleratus in enough soft, hot, salt water to saturate the skin. When the hands can be borne in the solution, put it in the skin and leave it twenty-four hours; then wring and hang to dry. Repeat the soaking and drying till the skin is soft and pliable. Finish by rubbing the inside with sandpaper and pumice stone. To color the skin, stretch it tightly, skin side down, upon a smooth board, and tack it firmly, then lower it into a bath of aniline dye, the color preferred, so the wool only will be submerged. Dip fifteen minutes, air and dip again. This is readily done if two persons hold the skin and move it gently until it is an even color. Rinse in the same manner. Be careful that the hot dye does not reach the skin. The above is an excellent method, but the following given in a newspaper may be equally good. Soak a fresh skin twenty-four hours in soft water, then scrape thoroughly to remove grease, flesh and blood. Repeat the process fifteen minutes for three or four days, sousing the skin up and down in the water until the wool is clean. When both sides are clean and sweet, it is ready for tanning. Lay it flesh side up and apply half the mixture of a pound of salt, half a pound of pulverized alum, half a pound of saltpeter, and twice the bulk of the whole of bran. Fold the edges toward the middle, commence at the head, and roll very tight. Let it lie a week in a cool damp place; then scrape off the mixture and apply the other half, sprinkling with a pint of water before the second application. At the end of the second week, hang the skin over a scantling, and scrape it with a chopping knife till it is soft; repeat for a day or two as it dries, then comb out the wool with a horse mane comb.—Country Gentleman.

For Smokers' Sore Mouth.—For sore mouth and gingivitis due to smoking, M. Viau (in Formulaire pratique, etc.) gives the following:

Salol	1 part.
Tincture of catechu	4 parts.
Tincture of green mint	100 "

Mix. To use, add teaspoonful to a half tumbler of warm water, and employ as a mouth wash.—National Druggist.

To Preserve Ink.—Those who have had difficulty with writing inks due to a dry skin forming on the surface when exposed to air, will welcome a hint from M. Robriquet, a French chemist, who recommends putting in a very small quantity of the red precipitate (deutoxide) of mercury.—Paper and Press.

Curry Powders.—1. (Said to be true Indian curry).

Coriander seed	360 grains.
Turmeric	100 "
Fresh ginger	260 "
Cumin seed	18 "
Black pepper	54 "
Poppy seed	94 "
Cinnamon	20 "
Cardamom	40 "
Cloves	20 "

One-half cocoanut, grated.

All but the cocoanut to be ground together. In order to obtain good results, the material should be selected with great care.

2. (Said to be Dr. Kitchener's.)

Coriander seed	3 ounces.
Turmeric	3 "
Black pepper	1 ounce.
Mustard	1 "
Ginger	1 "
Allspice	4 drachms.
Cardamom	4 "
Cumin seed	2 "

Reduce to a fine powder, mix thoroughly, and preserve in well stoppered bottles.

3. (Also given out as true East Indian curry.)

Coriander seed, powdered	8 ounces.
Allspice, "	2 drachms.
Mace, "	2 "
Caraway, "	2 "
Fennel, "	2 "
Celery seed, "	2 "
Turmeric, "	8 ounces.
Black pepper, "	1 ounce.
Capsicum, "	4 drachms.
Mustard, "	2 ounces.
Ginger, "	1 ounce.

—Bulletin of Pharmacy.

Solution for Softening Ear Wax.—

Boric acid	15 grains.
Glycerine	½ ounce.
Water	½ "

Make solution. Warm, and drop five to ten drops into the ear twice daily.—Registered Pharmacist.

Spray for Aphis.—Quassia chips, two ounces; water, one gallon; boil for fifteen minutes, and then dissolve in the liquid three ounces soft soap. To be used cold. Suitable for roses or apple trees.—Gardeners' Chronicle.

Brand's Liquid Glue (Drug. Zeit).—

Borax	60 kgs.
Water	100 liters.
Solution of potassia, 90 per cent	4 kgs.
Solution of glue, 12° B	1450 "

Dissolve the borax in the water, add to the boiling solution of potassa and to this add the hot solution of glue.—Western Druggist.

$250 PRIZE ESSAY COMPETITION—THE PROGRESS OF INVENTION DURING THE PAST FIFTY YEARS.

Fifth Prize, won by "VERBUM SAP. III." (FREDERIC DE GARIS).

THE rapid and marvelous advance made in the arts and sciences during the past half century is alone sufficient to distinguish this period; but when taken in connection with certain discoveries and achievements, it is unquestionable that this era will be memorable and will always command future respect and admiration. Well may it be called a progressive age!

In contemplating this development, we should bear in mind that in 1846 the world possessed great and important inventions, many of them the germ for others of equal merit, and many of them adapted for the new and novel industries we have introduced.

Macaulay says, "It is the age that forms the man, not the man that forms the age"; that "those who seem to lead the public taste are, in general, merely outrunning it in the direction which it is spontaneously pursuing"; yet we, like the nations in 1846, acknowledge our debt to the noted pioneers of invention; to Fulton, for the steamboat; to Watt, for the steam-engine; to Morse, for the telegraph; to Whitney, for the cotton-gin; to Jacquard, for the loom; to Hargraves and Arkwright, for the spinning-jenny; to Goodyear, for vulcanized rubber; and to scores of other illustrious men, whose thought and whose labor have forever linked them with especial fields of invention and discovery.

It seemed an omen of the intense activity we are witnessing when, in 1846, Elias Howe patented the modern sewing machine; an invention now so perfect, so cheap—applicable as much for use on many flexible materials as on cloth—that it has made toil easier and life happier for millions of people; for those who employ it, and for those who benefit through its agency.

Close upon the sewing-machine, and, like it, destined to lighten the fatigue of manual labor, came the improved harvesting machine of Cyrus H. McCormick, patented in 1847. Assuredly, this half century was well begun with inventions so humane, and which presaged the introduction of those appliances that everywhere have lifted the badge of labor to a higher plane, and have to-day almost superseded hand labor in thousands of industries.

And the process patented by Henry Bessemer, in 1855, for the transformation of carbureted iron into steel, was another invention of tremendous magnitude—justly regarded as one of the greatest inventions of this period.

It extended the employment of steel to immense proportions, from its main use in weapons of all sorts, in tools, and in springs; to machinery of all kinds; for boilers, bridges and rails; to ship building and other arts. It is true that these inventions, like nearly all notable inventions, were preceded by other patents and experiments directed toward the same end; but these were the first showing definite and practical results in their particular fields. Seldom does the inventor find unexploited territory; often he learns that others have simultaneously solved the problem with him. It is difficult, in many instances, to place full credit where it properly belongs.

Momentous achievements and important discoveries mark these early years; not the least was the location of the planet Neptune, by Leverrier and Adams, in 1846, producing a sensation that excited the world.

Nor should we forget that the utilization of petroleum became the basis for thousands of patents when, in 1859, it was found to flow in volume from artesian wells. And again, in 1858, the indomitable Cyrus W. Field laid the first commercial cable across the Atlantic. His idea, conceived in 1854, remarkable for its many failures in practice, but crowned with a brief success in 1858, was entirely successful in 1866, and it is noteworthy that the first message on this cable was the announcement of the treaty of peace between Prussia and Austria. Well might John Bright extol him as "the Columbus of modern times, who by his cable had moored the new world alongside the old."

The inventions connected with printing have advanced in orderly sequence, as though regulated by one master mind. From Richard M. Hoe's lightning steam-press, patented in 1847, and thought to be nearly perfect when its ten cylinders printed 30,000 sheets an hour on a single side, we now have the sextuple perfecting press, printing 75,000 eight-page papers an hour, with attachments by which 48 pages may be completely printed, pasted and folded. Soon the octuple press will be in use, with a capacity equal to eight single presses, and printing from 4 to 64 pages.

Then, too, the manufacture of paper from wood, or wood pulp, has almost reached perfection since Watt and Burgess, in 1854, patented the initial invention for producing it in large quantities; and so rapid that now the Adirondack lumberman may swing his ax into a spruce tree, see the log ground or chemically digested into pulp; this milky fluid cunningly fabricated into paper by one of the most admirable pieces of mechanism in the arts, and sent away; to be returned to him in a few days, in his newspaper; its clean, smooth surface telling him of the scurrying, throbbing outside world. In the United States, 12,000 tons of paper per day is the product of its mills; Germany's output is even greater, rags being used only for fine writing papers and a few books. And now we have the intricate and wondrous type-setting machines, each doing the work of three hand-setters—a result wrought by the several steps of many inventors here and abroad.

These inventions, together with the advances made in photography and the readiness by which illustrations are made; the improvement in methods of stereotyping, and the art of color printing of the best class, have aided in the enlightenment of the public as no others can.

Information is always in evidence; knowledge and art are constantly before us; and, more than all else, these inventions have cheapened the products of the press and conferred a boon to every one. The right-hand maiden of printing, the telegraph, has had its use amplified by the inventions of eminent electricians, culminating, in 1874, in the quadruplex telegraph, which allows four messages to be sent at the same time, in the same or in opposite directions, over a single wire. To us now it seems a short step from the telegraph to that annihilator of space, the telephone; yet, although the principle was first shown by Wheatstone in 1831, it was not until 1876 that Alexander G. Bell publicly exhibited the first one. Twenty years ago we had no telephone; now, with the quadruplex telegraph in mind, the spirit of the age demands that several persons may talk simultaneously over the same wire, that business may be facilitated and the cost of long distance telephoning reduced.

We also look forward to the day when, instead of depending upon the cable for quick intercourse with foreign lands, we may converse and may see the reproduction of the features of our confidant thousands of miles distant.

We expect these inventions because it has been reserved for this generation, skilled and equipped as never before, to inaugurate an electrical epoch which already fills the world with wonder. The history of our progress in this science is a record of innovations and incessant changes produced with a celerity fairly startling. The embodiment of the discoveries of many gifted minds—of Franklin, of Volta, Ampere, Faraday, Henry, and others equally famous—led, gradually, to the employment of the arc light for commercial purposes, and soon afterward by the practical perfection of the incandescent system of lighting, by Thomas A. Edison (that premier among inventors) sixteen years ago.

Systems invented by other men were also brought out, and to-day the extended use of the incandescent light is the best evidence of its appreciation by a grateful public. Can more be said to illustrate its universality than that some of the temples of India are to be thus lighted? Shades of Agni—the world moves! Well may you gasp and stare!

Discoveries in one branch quickly lead to the solution of problems in other branches, and, step by step, like the evolution of the electric light, many inventions have been made since the early seventies, in the production of electric power.

Symmetrical generators collect the invisible current and busy motors harness it. A mighty force, capable of taking life, of causing destruction; yet subdued and instantly controlled through man's genius.

The application of electricity to street railways is a marked feature of the times. In Europe, since 1882, one hundred and eleven street railways have come into existence; in the United States more than 700 lines use this new agent, whose speed is limited only by the requirements of the public, but whose motors, by proper winding, could attain any desired swiftness. Its employment has made it possible for the outlying suburbs about the great cities to furnish homes and health to vast numbers, and to correspondingly lessen the discomforts in dense and crowded districts.

This power is being developed, also, for use on steam roads. Its successful operation in hauling heavy trains through the Baltimore tunnel, and its performance on other railroads, is a premonition of coming transitions.

We note its gradual, but sure application to many of our daily wants—supplanting steam, hydraulic power, and in places, compressed air. Mines are worked by it; iron is welded and machinery of all descriptions is operated by it; a diminutive motor moves heavy cranes and elevators; massive drawbridges are swung. In a moment it obeys the commands of the guiding hand on ships of commerce and of war; it propels launches and draws canal boats.

Besides lighting our houses, it begins to heat our rooms, and fans us; it rings our door bells and opens our doors; it protects us by alarms; it advertises our wares, and is beginning to iron our clothing, take our photographs, and to do our cooking. Its use by physicians, surgeons and dentists has contributed to our knowledge and to the amelioration of suffering and pain—but its many adaptations are too numerous to dwell upon here.

A cheaper fuel or source of power to reduce its cost, is the present requirement. The utilization of water powers and artesian wells is a step toward this end, and made the long distance transmission of power a possibility. Previous to the wonderful exploit, last month, of sending the energy of majestic Niagara 465 miles to New York for exhibition purposes, the Germans had utilized the waters of Lauffen and transmitted the current 110 miles to Frankfort-on-Main.

In the interval many water courses have been made to supply power for shorter distances, principally in the Western and Pacific States of the United States and in Switzerland, and Niagara's latent spirit will soon invade many industries. The invention of a new type of furnace for the combustion of coal-dust refuse, or culm, promises to make this cheap fuel available in immense quantities in coal-producing countries. Another step, and one which is probably the first attempt to make practical use of the wasted force of the tides for electrical purposes, will be made at Santa Cruz, California. A dynamo is being installed which it is proposed to work by a head of water raised by the tide.

If electrical invention, together with the improvement of the vacuum, had led to nothing more than the astounding discovery of the cathode ray, brought to public light by Roentgen, in 1895, it would have served a useful end. We do not yet know what the amazing revelations of this discovery, disclosing the interior of the body to the human eye, may portend; but we know that its availability, and its application in the domain of surgery, anatomy and pathology, must benefit us.

Nor do we know what useful properties may develop in that inert gas, argon, the new element of the air, which Lord Rayleigh and Prof. Ramsay discovered in 1894.

Invention has produced new devices driven by compressed air. By it messages and packages are dispatched through miles of tubing; mines are worked and freight moved with its aid. Trains are stopped, and soon it may provide the long-sought car motor, which, with the success attending the underground trolley roads at Budapest and Washington, foretells the doom of many cable systems.

It is interesting to follow the metamorphosis of the modern bicycle from the velocipede invented by Von Drais, in 1817, propelled by the feet on the ground, to the graceful creation we now use. The invention of the pneumatic tire by Dr. Dunlop, in 1889, is an important date in this change. Other inventions helped to perfect it, and now the public everywhere has recog-

nized its utility and has adopted it for health, for business and pleasure in a manner which threatens to turn many lines of trade into new channels.

Invention, too, has made the typewriter an efficient servant of man and a great help to the blind. It has brought the locomotive to a point where its speed of a mile in less than a minute is an everyday occurrence. If only the Stephensons, Ericsson, and other leaders in this field could have lived to experience this!

In late years methods have been devised for extracting aluminum from the earth which have increased the output of this beautiful metal from the 83 pounds produced in 1883 to 6,000 pounds per day in 1896—permitting its wider use.

Invention has made improvements in the distillation of gas, and has given us the gas engine. It has discovered a new gas, acetylene, from calcium carbide; and has enabled us to employ natural gas. It is perfecting the motocycle, or horseless carriage. It is cheapening the manufacture of artificial ice and the cost of gathering the natural product.

Many inventions have contributed to the preservation of life from destruction by fire and by water. Wood and metal working machinery has reached a high degree of perfection. Delicate watches are made by machinery which excel the old time hand-made timepieces. Matches are finished and boxed by a unique machine which reduces the cost of labor from 27 to 4 cents per gross of boxes. With thirteen of these machines 340 employes in an Ohio factory turn out more matches in a day than 8,000 work people in the largest English match factory can produce in the same time. Mechanics work with tools, and agriculturists with useful labor-saving implements never thought of in 1846.

The progress of invention shows that in 1846 the United States alone issued 619 patents, with a white and free colored population of about seventeen millions; in 1895, with an aggregate population of seventy millions, 19,950 patents were issued to its citizens. It also shows that about 5,000 patents issued to women are now extant; many entering territory once thought to belong solely to man. Moreover, this progress has demonstrated that a genius is not always a crank.

We have arrived at a stage where invention has equipped all civilized nations with such deadly instruments of war that peace on earth is nearer than ever before. Ericsson's monitor, Harveyized steel armor plate, Hotchkiss and Maxim machine guns, the Whitehead torpedo, and smokeless powder are heralds of destruction which cause nations to hesitate before inviting a conflict.

But space does not allow us to consider other inventions which, with those named, have surrounded us with such improvements, such conveniences and comforts that we are permitted to live better lives and our days among the living are longer than those of our forefathers, fifty years ago.

[Continued from SUPPLEMENT, No. 1076, page 17195.]

THE SHADE TREE INSECT PROBLEM IN THE EASTERN UNITED STATES.*

THE FALL WEBWORM.

(Hyphantria cunea Drury; Figs. 9 to 11.)

ASSOCIATED with the white marked tussock moth in its damage to the shade trees of the city of Washington during the summer of 1895, were very many specimens of the fall webworm; in fact, this insect was more abundant during the summer of 1895 than it has been in Washington since 1886. It was not as numerous and destructive as the white marked tussock moth, and the last generation was so extensively parasitized as to lead to the anticipation that the species will not be especially abundant during 1896.

The fall webworm is a typical American species. It is found from Canada to Georgia and from Montana to Texas. It is an almost universal feeder, and the records of the Division of Entomology list about 120 species of shade and ornamental trees, as well as fruit trees, upon the leaves of which it feeds.

In the District of Columbia and north to New York City there are two generations annually, as is the case with the tussock moth. In more northern localities, where it is single brooded, it loses its place as a species of great importance. It hibernates as a pupa within a cocoon attached to the trunk of its food plant, or to tree boxes, neighboring fences, or to rubbish and sticks or stones at the surface of the ground. The different stages of the insect are shown in Figs. 9 to 11. The moth, which may be either pure white or white spotted with black, flies at night and deposits a cluster of 400 or 500 eggs upon either the upper or the under surface of the leaf. The caterpillars feed gregariously, and each colony spins a web which may eventually include all the leaves of a good sized limb. Reaching full growth, the caterpillars leave the web and crawl down the trunk of the tree to spin their cocoons. The caterpillars of the second generation begin to make their appearance in force in August.

Remedies.—On account of the fact that the adult female is an active flier, we can use against the fall webworm but two of the remedies suggested for use against the tussock moth caterpillars, namely, spraying with arsenical poisons and the collection of the cocoons. The gregarious habit of the larvæ, however, suggests another remedy which is practical and very efficient if thoroughly carried out. This is the destruction of the webs and the contained larvæ, either by cutting off the twigs which carry them and burning immediately, or burning the webs without pruning. If this work be done properly and against the early summer generation, the pruning method is unnecessary and inadvisable. By the use of a proper torch the webs and the caterpillars which they contain can be burned off at nightfall without necessarily destroying the life of the twigs, and a second crop of leaves will be put out a little later, so that the tree does not remain disfigured for any length of time. A bundle of rags wired to the end of a pole and saturated with kerosene makes a good torch for the purpose; or a porous brick wired to a pole and saturated with kerosene answers the purpose even better. Private persons will find this remedy sufficient. City authorities should apply an arsenical spray. Collecting the cocoons in winter may be carried on simultaneously with the collection of the egg masses of the white marked tussock moth, but this, as well as other community remedies, will be referred to at another place.

* By L. O. Howard, M. S., Entomologist United States Department of Agriculture. [Reprinted from the Yearbook of the United States Department of Agriculture for 1895.]

THE RELATIVE IMMUNITY FROM INSECTS OF DIFFERENT VARIETIES OF SHADE TREES.

As regards a number of the principal shade trees that are most commonly grown, there does not seem to be any great preference on the part of the fall webworm and the tussock moth caterpillar. If a moth happens to lay her eggs upon or near a given tree standing in a row, the species will naturally spread along the row before it will cross to the opposite side. In this way erroneous ideas of the relative immunity of trees have frequently been gathered.

FIG. 9.—Fall Webworm (Hyphantria cunea). Moths and cocoons—natural size (original).

Taking the insect question as a whole, however, there is a decided difference in the relative value of certain varieties. In December, 1893, the Tree Planting and Fountain Society, of Brooklyn, asked a number of experts to name for the use of the society nine of the most valuable trees for planting in Brooklyn. Three of these were to be large growing, three medium sized and three small growing varieties.

The reply of Mr. B. E. Fernow, chief of the division of forestry in the United States Department of Agriculture, was comprehensive and of great value. He tabulated nearly fifty varieties, analyzing their good qualities under the different heads of endurance, recuperative power, cleanliness, beauty of form, shade, leaf period, rapidity of growth and persistence, giving three as the highest mark for any one of these qualities and

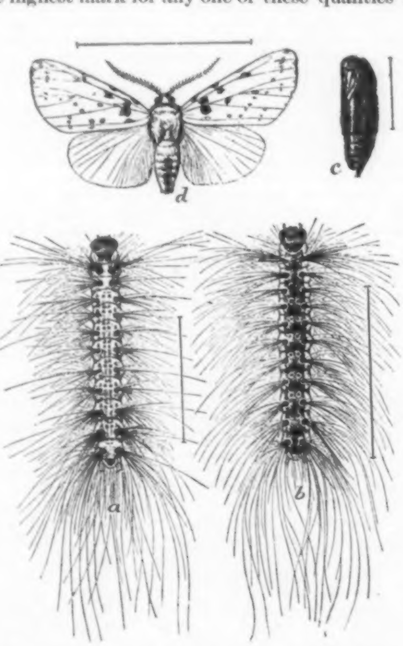


FIG. 10.—Fall Webworm. a, light form of full-grown larva; b, dark form of same; c, pupa; d, spotted form of moth (compare Fig. 9)—all slightly enlarged (original).

estimating the value of a given tree by the total number of marks given to it. This reply was printed and issued as a circular by the Brooklyn society. Mr. Fernow made no specific rating for immunity from insect pests, although in his introductory remarks he seems to have included the insect question under the head of cleanliness.

As is quite to be expected, the rating arrived at from the summing up of the qualities mentioned differs very considerably from the rating which might be arrived at from the quality of immunity from insects. Taking the large and medium sized trees only (thirty-six species in all), Mr. Fernow's rating stands as follows, only the total gained by the addition of the ratings in the several qualities considered being given:

Variety of tree.	Total rating (Fernow)	Insect rating (Howard)
LARGE SIZED TREES.		
Red oak (Quercus rubra)	22	2·5
Scarlet oak (Quercus coccinea)	22	2·5
Yellow oak (Quercus velutina)	22	2·5
American elm (Ulmus americana)	22	1·5
Sugar maple (Acer saccharum)	19	2·5
Black maple (Acer nigrum)	19	2·5
Tulip tree (Liriodendron tulipifera)	19	3·0
European linden (Tilia vulgaris)	19	1·5
Small leafed linden (Tilia microphylla)	19	2·0
Sweet gum (Liquidambar styraciflua)	19	2·0
White oak (Quercus alba)	19	2·0
Bur oak (Quercus macrocarpa)	19	2·0
Oriental plane tree (Platanus orientalis)	19	1·5
Kentucky coffee tree (Gymnocladus divisus)	19	2·0
American plane tree (Platanus occidentalis)	18	1·5
Sycamore maple (Acer pseudo-platanus)	17	2·0
American linden (Tilia americana)	17	1·5
MEDIUM SIZED TREES.		
Red maple (Acer rubrum)	22	2·0
Shingle oak (Quercus imbricaria)	21	2·0
Willow oak (Quercus phellos)	21	2·5
Slippery elm (Ulmus pubescens)	21	2·0
Norway maple (Acer platanoides)	20	2·0
Box elder (Negundo negundo)	20	0·0
European elm (Ulmus campestris)	19	0·5
Scotch elm (Ulmus montana)	19	1·0
Hackberry (Celtis occidentalis)	19	1·5
Silver leafed maple (Acer saccharinum)	17	1·5
Tree of heaven (Ailanthus glandulosa)	16	2·5
Horse chestnut (Æsculus hippocastanum)	16	2·0
Japanese sophora (Sophora japonica)	16	2·5
Hardy catalpa (Catalpa speciosa)	16	2·0
Gingko (Gingko biloba)	16	3·0
Honey locust (Gleditschia triacanthos)	15	1·0
Cottonwood (Populus monilifera)	15	0·5
Balm of Gilead (Populus balsamifera v. candicans)	15	0·5
Black locust (Robinia pseudacacia)	14	0·5

The writer has made ratings of these same trees according to their immunity from the attacks of insects, the trees most immune being rated at three and those most attacked by insects at 0. The figures relating to insect attack are displayed above in a contrasted column next to the total rating, and in order that the relative importance from the insect standpoint may be seen at a glance, the same trees have been rearranged in a separate table as follows:

Variety of tree.	Insect rating.
Gingko (Gingko biloba)	3·0
Tulip tree (Liriodendron tulipifera)	3·0
Sugar maple (Acer saccharum)	2·5
Red oak (Quercus rubra)	2·5
Ailanthus (Ailanthus glandulosa)	2·5
Scarlet oak (Quercus coccinea)	2·5
Yellow oak (Quercus velutina)	2·5
Willow oak (Quercus phellos)	2·5
Black maple (Acer nigrum)	2·5
Japanese sophora (Sophora japonica)	2·5
Horse chestnut (Æsculus hippocastanum)	2·0
Red maple (Acer rubrum)	2·0
Small leafed linden (Tilia microphylla)	2·0
White oak (Quercus alba)	2·0
Sweet gum (Liquidambar styraciflua)	2·0
Bur oak (Quercus macrocarpa)	2·0
Kentucky coffee tree (Gymnocladus divisus)	2·0
Sycamore maple (Acer pseudo platanus)	2·0
Shingle oak (Quercus imbricaria)	2·0
Slippery elm (Ulmus pubescens)	2·0
Norway maple (Acer platanoides)	2·0
Hardy catalpa (Catalpa speciosa)	2·0
European linden (Tilia vulgaris)	1·5
American elm (Ulmus americana)	1·5
Hackberry (Celtis occidentalis)	1·5
Silver leafed maple (Acer saccharinum)	1·5
Oriental plane tree (Platanus orientalis)	1·5
American plane tree (Platanus occidentalis)	1·5
American linden (Tilia americana)	1·5
Honey locust (Gleditschia triacanthos)	1·0
Scotch elm (Ulmus montana)	1·0
Cottonwood (Populus monilifera)	0·5
Balm of Gilead (Populus balsamifera v. candicans)	0·5
European elm (Ulmus campestris)	0·5
Black locust (Robinia pseudacacia)	0·5
Box elder (Negundo negundo)	0·0

It will be noticed that the trees listed by Mr. Fernow which we find to be most immune are the gingko and the tulip tree. Outside of the grounds of the Department of Agriculture at Washington and Central Park, New York, few gingko trees are grown in this country, except as occasional isolated examples. The tree itself is a very beautiful one, and singularly free from insect attack. In the long double row of these trees, now nearly twenty-five years old, on the grounds of the Department of Agriculture, but one species of injurious insect has ever been found, and the work of this species is very insignificant. It is the little sulphur yellow leaf roller, Tortrix sulphureana.

The tulip tree, which is given the same rating, is, for practical purposes, almost as exempt as the gingko. Of late years in the District of Columbia it has been rather extensively infested by a plant louse (Siphonophora liriodendri), but although the lice occur on the leaves in great numbers, the general appearance of the trees has not suffered. There is a little gall midge which produces little black spots on the tulip tree leaves and disfigures them to some extent, and quite recently Mr. Schwarz has found that tulip scrub is affected to some extent in the District of Columbia by a little bark-boring beetle.

The box elder is a singularly unfortunate choice for a shade tree in this climate. It is almost defoliated by the webworm, it is sought after by the tussock moth, and various leaf rollers attack it as well as certain destructive borers. In the West the box elder plant bug (Leptocoris trivittatus) breeds upon it in enormous numbers, and not only damages the trees to a serious extent, but causes much further annoyance by entering houses for hibernation.

The European elm is given a low rank, almost entirely on account of its annual defoliation by the imported elm leaf beetle.

The honey locust and the black locust, while not defoliated to the same extent as many other trees by the webworm and the tussock moth caterpillar, are rendered very unsightly almost every year by the work of a leaf-mining Hispid beetle and of certain Lepidopterous leaf miners. They are also frequently killed by the large

Lepidopterous borer, Xyleutes robiniæ, and certain Coleopterous borers also infest them.

From the insect standpoint, there are several fine-growing ornamental trees on the grounds of the Department of Agriculture, not listed above, which are seldom attacked by insects. The beeches, hornbeams, alders, and magnolias have very few insect enemies, and are rarely defoliated by either of the principal leaf-eating caterpillars.

With regard to the extreme attractiveness which the European elm possesses for the imported elm leaf-beetle, the question is frequently asked whether it would not be better to cut down all European elms growing in parks or in rows with American elms. Such a course, however, would seem to be undesirable. After the elm leaf-beetle has established itself in a given locality, it will attack the American elms to a very serious extent, in the absence of its favorite food plant. It is, therefore, better to allow a few European elms to remain. These will then act as trap trees, and the necessity for treating a large number of trees will in most cases be greatly reduced.

In selecting shade trees, particularly for small cities and towns in agricultural regions, and even to a considerable extent in large cities, the relative honey-producing qualities of the proposed shade trees is a matter of some little importance; not so much, perhaps, in the matter of actual food for the ordinary honey bee as in that of the increase of bees on account of their great value as cross fertilizers of orchard trees and forage crops. From this point of view, there are five very important honey producers among the principal shade trees. These are, in order of importance: American linden, tulip tree, black locust, horse chestnut, and sugar maple.

GENERAL WORK AGAINST SHADE TREE INSECTS IN CITIES AND TOWNS.

The question of proper work against the insects which affect shade trees in cities and towns naturally divides itself under two heads: 1. What can be efficiently and economically done by city governments? 2. If city or town administrators will not appropriate a small amount of money to carry on work of this kind, what can citizens who are interested in the preservation of shade trees do?

The planting of shade trees seems to be considered a legitimate function of the board of public works in every municipality. It is sometimes done by a specially appointed officer, under the control of the superintendent of streets and sewers; or it is placed in charge of a sub-committee of the board, or a special commission of outsiders is appointed to superintend the work. Admitting that the planting of shade trees is a public matter, their care should also be a public duty. Yet in not one of the larger or smaller cities of the Eastern United States with which the writer is familiar is any proper amount of work done by the public authorities against shade-tree insects. New York is the only city in the country where a man of entomological knowledge is employed to direct operations against shade tree insects, either in the streets or the public parks. The writer does not wish to be understood as advocating the appointment of a paid entomologist by every city government, although where the parks are large in cities situated within the region of greatest shade tree insect activity, such a course is always desirable. With an intelligent and industrious superintendent of parks, or a city forester, or whatever he may be termed, and the wise expenditure of a comparatively small amount of money each year, the shade trees of any city could be kept green throughout the summer.

The amount of money to be expended in this direction would naturally vary with the number of trees to be attended to, as well as with the variety and the size of the trees and the geographical location of the city. Even in Brooklyn, however (and this seems to the casual observer to be the most unfortunate of all our Eastern cities from this standpoint), it is within bounds to estimate that the expenditure of $4,000 to $5,000 a year would result in green shade trees the summer through. This amount, moreover, will in all probability not need to be an annual appropriation. The first cost of a proper spraying apparatus will have to be added, but the apparatus once purchased and thorough work performed for two or three years consecutively, the probabilities are strong that the number of shade tree insects would be reduced to such an extent that a considerably smaller annual expenditure would be sufficient.

The question of proper spraying apparatus is a rather serious one, since in this direction a considerable amount of money should be expended. A steam apparatus will do the work with much greater rapidity than a hand pump, and yet with a strong double-acting force pump, which can be operated by a single man, and a tank of 100 gallons capacity, mounted upon a strong cart, many large trees can be well sprayed in the course of a day. From such a pump two lines of hose may be run with advantage. The working force of such an apparatus should be a horse to draw the cart, a man to drive and do the pumping, and one man to each line of hose. Several such machines have been used with good results in the work of the Gypsy Moth Commission, both for the street trees and in the public parks. A steam apparatus, however, of such a capacity that a pressure of 75 pounds per square inch may be gained will enable the operation of four or five lines of hose simultaneously. The rapidity of work will therefore be doubled, and certainly by the use of two such pumps the shade trees of any ordinary city can be gone over with sufficient rapidity to destroy all insects within the required time. A boiler mounted on a truck, the boiler to be complete with all fixtures, smokestack, bonnet, firing tools, springs to the truck, and a pump having a capacity of 10 to 20 gallons a minute connected with the boiler ready for operation, can be purchased for a sum well within $500. This truck should be mounted on wheels with broad tires, for running over sandy roads. Connecting this apparatus with a proper tank cart would be an additional expense, not to exceed $100 for a tank of a capacity of 200 gallons. Such an apparatus, furnished with hose and smoothbore nozzles of about one-sixteenth inch in diameter, when discharging under 40 pounds pressure from each of several such nozzles, would spray about half a gallon of insecticide mixture per nozzle per minute.

A strong steam pump, to be used in connection with a small oil-burning boiler, the whole apparatus on a smaller scale than that described above, has been estimated at $275 by a prominent New York firm, delivered on board the cars.

There is no reason why an old steam fire engine could not be readily arranged for this shade-tree spraying work. In one or two instances a steam fire engine has been used for this purpose without modification, the object being simply to knock the insects from the trees by means of a strong stream of water. By such means as this the superintendent of the Military Academy kept the elm trees green at West Point several years ago. In every large city, where the fire department is necessarily kept in the best condition, an engine is occasionally retired. The transfer of such a retired engine to the street department could no doubt be readily made, and a little work by a competent steam fitter could transform it into a most admirable insecticide machine. In this way the initial expenditure for machinery would be avoided.

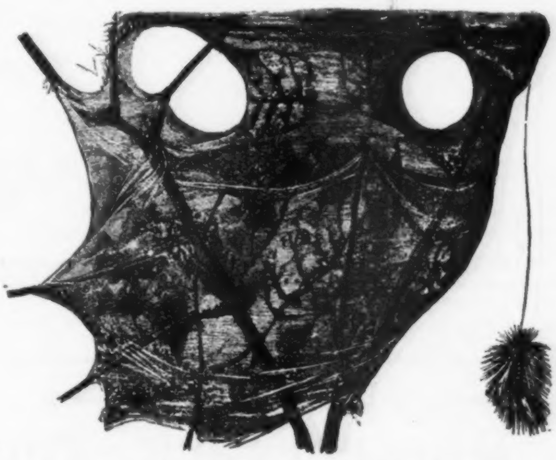


FIG. 11.—Fall Webworm. Suspended larva and section of web—natural size (original).

When the spraying apparatus has once been provided, the funds necessary for the purchase of insecticides and the necessary labor at the proper time must be available. If the work is not done promptly and at just the right time, more or less damage will result, and a greater expenditure will be necessary. During the latter part of May and the first part of June, in the case of nearly all prominent shade-tree insects, one or two thorough sprayings must be made. In fact, a second spraying, begun immediately after the completion of the first one, will in ordinary cases be as much as need be expected. In addition to this spraying work, a force of men must be employed for a time in July to destroy the elm leaf-beetle larvæ as they are descending to the ground and to burn the webs of the first generation of the fall webworm. This will finish the summer work. The winter work will consist of the destruction of the eggs of the white-marked tussock moth, the cocoons of the fall webworm, and the bags of the bag-worm. The number of men to be employed and the time occupied will depend upon the exigencies of the case. Upon the thoroughness of this work will depend, to a large extent, the necessity for a greater or less amount of the summer work just described.

We have now to consider what can be done by citizens where city governments will not interest themselves in the matter. It is unreasonable to expect that a private individual will invest in a spraying apparatus and spray the large shade trees in front of his grounds. Therefore, in spraying operations where large trees exist in numbers there must be combination of resources. This affords an opportunity for the newly invented business of spraying at so much per tree. A resident of Bridgeport, Conn., who was formerly, and is yet for the greater part of the year, a roofer and paver, has constructed several cart sprayers, and during the months of June and July (at a time, by the way, when the men in his employ are apt to be out of work) he sprays trees on the grounds of private individuals and along the streets in front of their grounds, under contract, at so much per tree, guaranteeing to keep the trees in fair condition during the season. His work has been directed solely against the elm leaf-beetle, since that is the only insect of great importance in Bridgeport. In the month of July last the writer, in driving through the streets of Bridgeport, found it easy to pick out the trees which had been treated in this way. Such elms were green, while all others were brown and nearly leafless. The defect of this plan as a general practice lies in the fact that not all property owners or residents can afford to employ a tree sprayer, while others are unwilling, since they deem it the business of the city authorities, or do not appreciate the value of tree shade.

Any effort, therefore, looking toward the arousing of popular sentiment or the banding together of the citizens in the interests of good shade is desirable. A most excellent plan was urged by one of the Washington newspapers the past summer. It advocated a tree-protection league, and each issue of the paper through the summer months contained a coupon which recited briefly the desirability of protecting shade trees against the ravages of insects, and enrolled the signer as a member of the league, pledging him to do his best to destroy the injurious insects upon the city shade trees immediately adjoining his residence. This is only one of several ways which might be devised to arouse general interest. The average city householder seldom has more than a half dozen street shade trees in front of his grounds, and it would be a matter of comparatively little expense and trouble for any family to keep these trees in fair condition. It needs only a little intelligent work at the proper time. It means the burning of the webs of the fall webworm in May and June; it means the destruction of the larvæ of the elm leaf-beetle about the bases of elm trees in late June and July; it means the picking off and destruction of the eggs of the tussock moth and the bags of the bag-worm in winter, and equally simple operations for other insects should they become especially injurious. What a man will do for the shade and ornamental trees in his own garden he should be willing to do for the shade trees ten feet in front of his fence.

THE DEVELOPMENT OF NEWFOUNDLAND.*

IT is rather singular that for five hundred years after its discovery the island of Newfoundland should have had no curiosity to turn her eyes away from the sea and the marine interests that related exclusively to a marginal strip of land not more than a mile or two inland from the ocean strand. Such a fact proves more than anything else the great value and remunerative character of the Newfoundland fisheries. These fisheries are as abundant and prolific to-day as ever they were. The trouble about them is that they are too prolific. A hundred years ago, when the modern history of the island may be said to have begun, there were only 10,000 people in Newfoundland altogether. In 1786 the whole number was 10,701. Twenty years before that the French had withdrawn all their pretensions to Nova Scotia in exchange for the privilege of fishing on the northern coasts of Newfoundland, and it is on record that from that time the French fisheries rapidly increased. At that period the quantity of British codfish exported from Newfoundland was between 500,000 and 600,000 quintals. In 1840 it rose to a million of quintals. It is now (1896) between one million and a million and a half. Between the two periods it has been as high as 2,000,000 with corresponding fishery products of other sorts in like proportion. It is a circumstance worthy of special note that during the life of the present nineteenth century, and while the resident population has increased from about 10,000 to nearly 210,000, the products of the fishery, on which this population are supposed to exist, have either increased in a very small ratio, or have not increased at all. In other words, the population has increased twenty-one times, and the producing harvest has either remained stationary or has only increased by less than double.

At last the increasing burden of trying to support the ever-multiplying number of mouths with the same amount of food stimulated the Newfoundlanders to try what a go at the land might produce. They were not without some previous indications in this direction, for the peninsula of Avalon, which is only a wing of the main island, already sustained, partly by agricultural pursuits, fully one-half the 200,000 population in 1880. But it was not known whether the main island, which was entirely unexplored, was equal in agricultural resources to Avalon, or contained any agricultural land at all. In order to reach these interior lands it was necessary to build a trunk line of railway through the center of Avalon. This was done in 1881–82, and eight years after this main line was extended north to Gambo, the Bay of Exploits and the Gander River. Branches were also extended to Trinity and Placentia Bays. During the past year (1895) the main line has been further extended right across the island from the east to the west side. The western terminus is at Bay of Islands, fronting the Gulf of St. Lawrence, between which place and the eastern side of the island is a distance of 300 miles. As this last exploit was completed last autumn, just before the travel closed down for the winter, there has not been opportunity to report on the character or value of the natural resources then for the first time rendered accessible. Some carloads of coal were brought out to St. John's, and one or two groups of sportsmen went over the line to the construction terminus before the frost came, and then the work closed down until the opening of next spring. Meanwhile, daily trains run between St. John's and Whitbourne, Harbor Grace and Placentia, and twice a week a train runs north as far as Norris's Arm.

The immense region thus opened up to exploration occupies an area of nearly 40,000 square miles, and includes the whole north, west, and south coasts of the island. The region abounds with evidences of mineral wealth of one sort or another, including iron, copper, and coal, besides an immense variety of allied mineral deposits. Of the comparative value of these, in a commercial sense, little can yet be said; but now that the locality has been made generally accessible, all the facts will soon be known. In natural history the new territory is also interesting, principally on account of the vast herds of caribou, or native deer, which for centuries have found here their suitable habitat. Hitherto these gentle creatures have been only slaughtered in individual numbers for the sake of their antlers, or by the coast settlers for use as food. It is to be feared that the whole species will now be soon exterminated. The interior also abounds with partridge or native "grouse," with plover, curlew, and snipe. Seafowl of many

* James Murray, ex-M. H. A., in the Canadian Gazette.

varieties, wild ducks and geese, fly over the land in their respective seasons. The fur-bearing animals natural to North America—fox, wolf, bear, otter, beaver, musquash, hare, and rabbit—are common in this section. Reptiles of all sorts have no existence.

The natural features of the district of a superficial kind are such as are common to many northern lands of the Norway type, and consist of vast plains in the center of the island with numerous chains of hills and watersheds toward the coast. Large bodies of fresh water exist everywhere, and wherever the river valleys are found the banks are well wooded and the land in the neighborhood is rich and fertile. As a rule, however, the general aspect is that of rock and water, pointing much more promisingly toward mineralogy and mining than to the agrarian harvests of field and fold. Chief among the natural features of landscape along the railway track is the large body of water known as Grand Lake, fifty-six miles long and five wide, which occupies an area of nearly 200 square miles, with mountainous shores 1,000 feet high, and containing an island, known as Sir John Glover's Island, which is itself twenty-one miles long and two broad. Near by is "Deer Lake," also of considerable proportions, being fifteen miles long. These lakes are drained by the "Humber" River, which falls into Bay of Islands on the west coast, a majestic stream of large proportions, which runs for a distance of eighty miles, and is navigable from its outlet into the sea for a distance of fifteen miles inland for ships of the largest size.

The future possibilities of trade, travel, and settlement in connection with the area now developed it is not easy to anticipate at this stage, but it is quite certain that the island colony is now entering upon a new phase of its existence, which will either enable it to support a much larger population than at present, or demonstrate the fact that it must forever afterward limit its history to that of a fishing country whose dimensions and limitations are of the sea rather than of the soil. The new railway across the island will afford a readiness of access to it through the western portal for travelers from the United States and Canada who may wish to avoid the sea passage in summer time and journey down through the maritime provinces of New Brunswick, Nova Scotia, or Cape Breton. A steamer will cross the Straits from the Cape Breton shore, a distance of only about sixty miles, and connect with the railway, so that travelers may be in Newfoundland by this route within twenty-four hours of leaving Halifax, and in St. John's (if need be) within forty-eight hours of Halifax. The route may also be availed of in connection with a short passage across the Atlantic from St. John's of possibly three or four days. The closing four or five years of this century will determine all these points, and show whether "the Atlantic isle" has any connecting links to establish between the two continents.

ITALIAN THUNDERSTORMS.

The Roman correspondent of the Lancet says that the thunderstorms that have recently visited many of the Italian provinces have done very serious damage to property and occasioned much loss of life. The Ligurian seaboard has suffered exceptionally. "Ball lightning has been witnessed several times, the most dangerous and destructive, fortunately the rarest, form which the 'thunderbolt' is known to assume. Providentially, however, it has this year numbered no victim in Italy. But the ordinary lightning stroke has caused much loss of life, to say nothing of many grave lesions more or less permanent. Four fatalities are reported from the recent thunderstorm at Genoa, all instantaneous; and at Ventimiglia, in the sacristy of a church, where six priests were assembled, four were killed outright, and the two survivors are in a desperate condition.

"As a rule, lightning stroke is most common in the open air, generally under the tree to which the victim has resorted for shelter, and this circumstance, even where only severe injury has been sustained, makes death more likely, as the measures for relieving shock and restoring the vital energies cannot be put in practice till too late. But this year the majority of fatalities from lightning have occurred in dwelling houses. There is no doubt that for this greater frequency of thunderstorms, as for the more prolonged drought and such like meteorological visitations of latter years, the steady tree felling, unbalanced by tree planting, is directly responsible." This account is fully borne out by the reports which have from week to week appeared in L'Elettricita, that journal regularly giving a certain amount of space to the subject.

It would be interesting to know what authority the Lancet correspondent has for considering ball lightning to be particularly fatal. One of the Italian cases happens to have been described in L'Elettricita. Two servants were in the room when the "fireball" entered. One ran out, but the other could not. When the ball "exploded," the latter is stated to have sustained a "burn," but was not seriously hurt. The phenomenon is so rare, and the observers are naturally so frightened, that very little is really known about it, and some have even doubted its real existence. Prof. Righi, of Bologna, is stated, by using condensers of great capacity and a large resistance in the circuit, to have succeeded in obtaining a discharge from a Holtz machine which would seem to bear the same relation to ball lightning that the ordinary spark does to the "forked" flash. But this is about as far as experiment has gone in the matter, while the theory of the subject is an absolute blank. As to the question of the denudation of the forest land producing thunderstorms, the evidence is very conflicting. The nature of the forest, whether pine, oak, or beech, has probably a great deal to do with it. But obviously in a flat, treeless country there will be more fatalities to men and animals than where there are trees or other elevated objects to take the discharge. Consequently a mere counting of accidents is beside the question. Even in classical times Italy was a bad place for thunderstorms.

The largest single plant in the world for carrying on the pulp and paper business is said to be that located at Corinth, N. Y., where some 35,000 cords of Canada short wood and 12,000 cords of logs are used annually, while the wood carrier or trestle is 1,025 feet in length and its capacity 30,000 cords of four foot wood. The branch and yard railroad consists of four miles of tracks, and about seventy carloads of wood and logs are received daily. The amount of printing paper manufactured is some 100 tons a day, this vast amount being sent not only to various great cities of the Union, but about 180 tons a month are shipped to England and Australia. The manufacture of wood pulp per day, with the new wheels furnishing 15,000 horse power, is estimated to reach a capacity of 125 tons of paper. Forty tons of sulphite are produced daily.

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